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THE OLDEST RAILROAD PAPER IN THE WORLD.

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A CORRESPONDENT informs us that one of the old steam carriages for use on common roads which were described in the JOURNAL for August is still in existence, and is preserved in the Patent Museum at South Kensington, London. It is interesting to know that such a relic still exists and can be seen and studied by modern inventors.

THE advocates of the Lake Erie & Ohio River Ship Canal have suggested an argument in its favor in addition to the commercial advantages which it offers. This is that, in case of war, ships of the size of the *Yorktown* or the *Concord* could readily be passed through the canal for service on the Lakes. Moreover, war-ships of considerable size could be built at Pittsburgh, where material is abundant, and sent up to the Lakes. In this way the canal would be an important addition to the military power of the country.

FOR the first half of 1891, according to the figures collected by the American Iron & Steel Association, the production of pig iron in the United States was 3,371,925 gross tons; a decrease of 1,188,588 tons, or 26 per cent., as compared with the first half of 1890. The decline was greatest in Pennsylvania, Ohio and Illinois, the leading Northern producing States; it was less marked in the Southern iron districts. The greatest reduction also was in iron made with bituminous coal and coke, the anthracite and charcoal furnaces showing a much smaller percentage of decrease. The reduction was due partly to labor troubles in the coke districts, but probably more to the general inactivity in business which marked the early months of the year.

ACCORDING to the same authority, the production of Bessemer steel for the first half of 1891 was 1,599,096 net tons; a decrease of 442,143 tons, or 27½ per cent., from the first half of 1890. The causes for this decrease were very nearly the same as for that in pig iron, and, in fact, the two generally run in nearly parallel lines.

It is interesting to note that every year the proportion of the total steel production made into rails decreases. In the first half of 1891, of all the Bessemer steel ingots made 36¼ per cent. were rolled into rails, while in the first half of 1890 the rail mills absorbed 50½ per cent. This shows the rapidly growing use of steel in construction, which we have heretofore noted from time to time.

The rail production for the half year was 579,929 tons, the smallest recorded since the first half of 1885. In fact the decrease in steel production was entirely in rails.

THE figures gathered by *Poor's Manual*, while not all that could be desired, are of much interest as making the best available showing of the general condition of the railroads of the country. A few figures from this source will show the magnitude of the railroad interest in the United States. These are for the year 1890:

Miles of railroad	163 420
Miles of track, including second track, etc.	208,303
No. of locomotives	32,241
No. of passenger-train cars	30,211
No. of freight cars	1,061,970
Total train mileage	793,925,145
Passengers carried	520,439,082
Passenger-miles	12,521,565,649
Tons freight carried	701,344,437
Ton-miles	79,192,985,125
Gross earnings	$1,086,040,207
Net; above working expenses	341,666,369

As the total liabilities reported—stocks, bonds and floating debt—amounted to $10,393,781,120, the net earnings, or surplus over operating expenses, were last year about 3¼ per cent. on the liabilities, which nominally represent the cost of the railroads. The surplus after paying interest, rentals and other fixed charges was 2.9 per cent. on the amount of stock reported.

The average earnings per passenger-mile last year were 2.185 cents, a slight increase over 1889; per ton-mile they were 0.935 cent, a slight decrease. The average gross earnings per mile of road in 1890 were $6,946, an increase of $422 over 1889, while the net earnings per mile were $2,195, an increase of $100. These gains were perhaps due to improvement in business, but in part, doubtless, to the fact that much less new mileage was included in the returns for 1890 than for several years past.

Last year was generally a good one for railroads, and in 1891 the prospect is that the closing months will almost be able to make up for the depression of the earlier part of the year.

THE manœuvres of the Squadron of Evolution have served a good purpose, not only in training the officers and crews, but also as a sort of object lesson in showing the people of the great seaboard cities the progress made in building up a new navy and in cultivating their appreciation of its excellence. It does seem, however, as if the Squadron had almost reached the limit of its usefulness in this direction, and it would be well to send the cruisers in various directions abroad, where their services are needed, and where the United States is now represented only by old and almost worn-out ships. Such a course also would show better the merits and defects of the new ships and enable us to avoid the latter in the future.

Probably the most useful ships in time of peace will be the cruisers of the 2,000 and 3,000-ton classes, which ought to be very efficient on the China and Pacific stations, for instance, and at other points where a war-ship is likely to be needed. These vessels promise to be very handy and

efficient boats, while their cruises can be conducted at a moderate expense. It is not intended to depreciate the value of the larger cruisers and battle-ships which are necessary to a complete navy; but the smaller vessels should not be neglected.

THE Central and some other lines in the Argentine Republic, which are under foreign control, have met the monetary crisis in that country by raising rates so as to keep them on substantially a gold basis. The result has been a very heavy loss in traffic. Part of this is probably due to the general commercial disturbance, but much of it to the increased rates, which the traffic is not able to bear. Great complaints are made by shippers, and the condition of affairs is shown by the fact that considerable shipments are being made to the ports on the Rio de la Plata by bullock carts, reviving the old method of transportation which the railroads had replaced. The complaint is general that the English boards of directors cannot or will not understand the local conditions, and that the course they are taking is injurious both to the railroads and to the country generally.

THE CARE AND CLASSIFICATION OF NOTES, MEMORANDA AND PAPERS.

IN the very interesting "Journal of Sir Walter Scott,"* which has recently been published, the distinguished author says:

> I cannot conceive what possesses me over every person besides to mislay papers. I received a letter Saturday at *e'en*, enclosing a bill for £750. Well, I read it, and note the contents; and this day, as if it had been a wind-bill in the literal sense of the words, I search everywhere, and lose three hours of my morning—turn over all my confusion in the writing-desk—break open one or two letters lest I should have enclosed the sweet and quickly convertible document in them—send for a joiner, and disorganize my scretoire lest it should have fallen aside by mistake. I find it at last—the place where is of little consequence; but the trick must be mended.

In another place, when he was writing the "History of Napoleon," he says:

> It makes me tremble to think of the mass of letters I have to look through in order to select all those which affect the life of *Napoleon*, and which, in spite of numerous excellent resolutions, I have never separated from the common file from which they are now to be selected. Confound them! but they *are* confounded already. Indolence is a delightful indulgence, but at what a rate we purchase it.

It is a curious fact that most of us feel flattered when we discover the same defects of conduct and character in distinguished people that we have ourselves, and it may perhaps be consoling to some of our readers to know that Sir Walter Scott had the same weakness which they have suffered from so often.

We are not all as systematic as we should be; and we are reminded of this oftenest, perhaps, by the apparent sudden disappearance of a paper of some kind which, for the time being, seems to be possessed of a spirit of exasperation. Artemus Ward's expression of "the cussedness of inanimate things" seems to describe some active principle which at times takes possession of papers, notes and memoranda. A retrospective view of such occasions, it is true, generally results in a sort of penitentia' sense of carelessness, which Sir Walter confessed and resolved—as we all have—to mend.

Nearly everybody keeps a memorandum book of some kind which is, perhaps, all that is needed for those who make few notes or have retentive memories. But there are occupations in which a great many memoranda must or should be made. Sometimes these must be stored away for future use when the recollection of them has been dimmed and their location is forgotten. Besides making and preserving memoranda, few of us, in these days of much printing, escape the obligation or the desire of preserving "scraps." The daily papers, technical journals, books, pamphlets, advertisements, are showered upon us, and we find much material which it is desirable to preserve or index in some way so that it will be within easy reach when needed. The memorandum books of busy people increase in size and number, so that the notes which were made a week, a month, a year, or five years ago cannot be found without a long search and the waste of much valuable time. Most people at some time or other begin keeping a scrap-book. The beginning usually ends in a dismal failure. The work of pasting scraps in a book, and then of indexing them so that they can be found, is so great that few persons persist in it. There is the difficulty, too, of preserving scraps which are printed on both sides of the paper, and also the fact that much of what is preserved in time becomes obsolete or useless. For busy men scrap-books are impracticable unless they have adequate assistance at command. As a consequence of the necessity of making and preserving memoranda and scraps of various kinds, and of the difficulty of doing it satisfactorily, most persons struggle along with the aid of a few books, pigeon-holes, and profanity as best they can, and at times, like Sir Walter Scott, they anathematize their papers and their own careless habits. To all who, by necessity or inclination, collect much miscellaneous material of the kind referred to, what is called the "card catalogue system," for want of a better name, is a great boon and of inestimable service both in the saving of labor in filing such material and in referring to it thereafter. Some years ago a description of this system, which was published in another journal, attracted a good deal of attention, and seemed to interest many readers; and as subjects for editorials which can be written or read in midsummer should not be too abstruse, an explanation of this system will be given again for the benefit of those who have not seen or have forgotten the first one.

The system probably originated or was derived from that employed for catalogues of libraries. Every one who has ever had any experience with either manuscript or printed catalogues in book form knows how imperfect and confusing they become as soon as any very material additions are made to the library. The titles to the new books must then either be interlined or interleaved, and as soon as any considerable number are added, confusion in the classification follows. For this reason the catalogues of many public libraries are now kept on cards. Each title is entered on a card about the size of an ordinary postal-card, and these are then arranged in alphabetical order in suitable receptacles in drawers. When a new book arrives its title is at once written on a card and it is placed in its proper alphabetic position, so that the catalogue is always complete, and the order of classification is not disturbed by entering new titles. It may be essential, and generally is, to index books in several different ways. Thus if we had the MANUAL of Marine Engineering, by A. E. Seaton, its title might be written on the card as follows:

* The "Journal of Sir Walter Scott," from the original manuscript at Abbotsford. Harper & Brothers, New York, 2 vols.

MANUAL of Marine Engineering, by A. E. Seaton.

and it would then be filed just as a word in a dictionary is arranged, in the department devoted to the letter *M*, and in the order of *MAN*. Or it might be written:

MARINE Engineering, Manual of, by A. E. Seaton, or

ENGINEERING, Manual of Marine, by A. E. Seaton, and placed after *MAR* or *ENG*. As we often look for books by their author's name, it would probably also be entered with the author's name first, thus:

SEATON, A. E. Manual of Marine Engineering.

It will thus be seen that the first or the index word entered on the card will be our guide in finding the book, and therefore in using the system both for catalogues and for preserving memoranda, etc., the facility of finding what is thus filed will depend very much on the selection of the index word or words. As has been shown, in making catalogues of books it is often important that they be entered under more than one index word. The same thing is true of the filing of memoranda, etc.

The system for the latter purpose will probably be most readily understood by describing its use in its simplest form. In fact, there is not very much to explain after the description of the method of keeping library catalogues, as its application to the preservation of memoranda, etc., consists simply of selecting an index word for the memorandum, and then writing the word on a card first and the memorandum after it. While many persons who use the system use cards on which they write what is noted, it will be found that an ordinary envelope is equally convenient for this purpose, and has the additional advantage that scraps cut from papers, etc., can be placed inside of the envelope with an index title on the outside and then filed in their proper place.

To begin this system of preserving and classifying memoranda, etc., all that the beginner need do is to buy a box of a "half thousand" envelopes—what are known to the trade as Number 6¼ "government" is a good size. These are 6 × 3⅝ in. Any other size will answer, however.

Now suppose it is learned that the weight of a locomotive is 80,000 lbs., and it is desirable to preserve a memorandum of it, all that need be done is to write on one of the envelopes an index word—which in this case would obviously be "Locomotive"—with the weight after it, as follows:

LOCOMOTIVE. Weight of No. 2 on Pa. R. R., 80,000 lbs.

As it might be expected that this item of information would be indexed under the word "weight," the latter might also be written on another envelope, with a reference to the first one as follows:

Weight. See Locomotive.

Or suppose a description of the Nicaragua Canal should be found in a paper, and for some reason it would be desirable to preserve the article, it could be cut out, folded, and deposited in one of the envelopes, and the index title NICARAGUA Canal written on the outside.

Or, to continue the examples, supposing that in reading the following maxim is encountered, "*Stubborn clients build fine houses for lawyers.*" It might be filed under the general title "Maxims," or under "Clients," "Lawyers," or "Stubborn Clients," or all four titles might be used. If the definition, "*A bore is a person who talks to you about himself when you want to talk to him about yourself,*" should seem worth preserving, it would be indexed under the word BORE, with the definition either written after the index title or deposited on the inside of the envelope. If the address of one of the Smith family was to be recorded, the entry on the envelope would be SMITH, John, 175,299 Peanut Street, Philadelphia.

Another excellent use which may be made of this system is the indexing of notable articles in periodical literature. Thus *The Engineer* recently had a description of one of the American "whaleback barges" which made a voyage across the Atlantic. The record of this would obviously be—WHALEBACK barges. See *The Engineer*, Aug. 7, 1891, page 111, and BARGES. See Whaleback Barges. We all read articles to which it may be desirable to refer in the future, but which can then only be found with an expenditure of time and trouble which we cannot spare. A simple entry on an envelope with a suitable index word, with the title of the article, the name, date and page of the publication in which it appeared, will make it accessible at any time.

The uses of this system are almost infinite. It can be used for preserving and classifying any kind of data, from domestic receipts to mathematical formulæ. An envelope with a record of books loaned will often secure the return of volumes all trace of which would otherwise be lost.

There are also many incidental advantages connected with the system. It always happens that much of the material which we collect becomes useless and obsolete. When this occurs, all that need be done is to destroy the envelope and its contents on which the obsolete material is recorded, or in which it is deposited. The continuity and completeness of the system is not disturbed thereby.

Another convenience grows out of the fact that all the material relating to any one subject is brought together, and when it is needed can be carried away without disturbing anything else.

As soon as the envelopes have titles written on them they can be placed in one end of the box and arranged alphabetically, the blank envelopes being kept in the other end. As the memoranda increase it will be found convenient to place colored cards, about one-quarter of an inch wider than the envelopes, between them. Each card should have one of the letters of the alphabet on its upper left-hand corner. This will facilitate the alphabetic classifica-

tion. When the number of envelopes to be taken care of increases still more, cards of another color should be used, with three letters of the alphabet like the index letters at the tops of the pages of a dictionary.

The system has the great advantage of elasticity, and can be adapted to all sorts of uses. A few envelopes can be carried in a pocket-book, and memoranda can be made anywhere and at any time, and then classified when convenient.

A little use will soon show the beginner that the paper box in which his envelopes were packed is too frail to stand much wear, and he will find that one or more drawers divided into spaces of the width and depth of the envelope box will be required if he continues and enlarges the use of this system.

It will be found, too, that ordinary envelopes will not be large enough to contain all the material relating to certain subjects which will be collected. For such subjects what are known as document or box envelopes may be used. These can be made of any size, but those measuring 4 × 9½ × ½ in. are a convenient size.

Still other subjects will require more room, and drawers or pigeon-holes must then be resorted to, especially if pamphlets are to be added to the collection. A little ingenuity will adapt the system to any occupation, study or profession. The chief difficulty will be found in the selection of index words. A word selected to-day may not be the one which would indicate to us the same subject six months hence. Consequently liberal cross-references are required.

This system can be used for the simplest purposes, and can be adapted for any complicated or extended uses. No better plan can be found for keeping a record of domestic receipts; and students, engineers, authors, and especially editors will find it admirably adapted for preserving all kinds of material.

TRAFFIC AND SHIPPING ON THE GREAT LAKES.

OUR attention has been called to the fact that the conclusions and comments made in the article under this title, which was published in the June number of the JOURNAL, and which were based on the figures given in Census Bulletin No. 29, are to some extent incorrect, as the figures given in that Bulletin are imperfect. It seems that in the tables given in Bulletin No. 29 all tonnage was omitted that, in the judgment of the Bureau, was "unimportant," but there is no indication as to where and how the dividing line was drawn.

In making up its report on the ship canal between Lake Erie and the Ohio River, the Pennsylvania Canal Commission collected very carefully statistics of Lake shipping. These statistics have been carefully revised and are used effectively in a letter written by Mr. John M. Goodwin, a very active member of the Commission, to the Pittsburgh *Dispatch*, in criticising the Census statement.

As showing the importance of the difference, we give below, side by side the figures of the two statements as to the total floating equipment on the northwestern lakes:

	Bulletin No. 29.	Canal Commission.
Side-wheel steamers	39	61
All other steamers	1,026	1,374
Sailing vessels	882	1,247
Total	1,947	2,682
Total difference		735

The Canal Commission statement seems worthy of credit, and is also confirmed by a later Census Bulletin, No. 66—issued after the article in question was written—which gives a total enumeration of 1,432 steamers and 1,259 sailing-vessels.

In a matter of such importance it is well to have correct figures; and although many of the comparisons made and conclusions drawn will not be materially changed, some of the averages given as to tonnage, etc., will not stand.

Mr. Goodwin's letter, above referred to, is an interesting one, and only lack of space prevents us from publishing it in full. Though written mainly in the interest of the canal, it contains some figures and statements of general interest.

The principal changes which are required in the figures are an increase in the proportion of freight carried by sailing vessels, and a decrease in the average tonnage of steamers.

One conclusion drawn by Mr. Goodwin seems to be supported by the strongest arguments. It is that the maintenance of 20 ft. channels and corresponding water in lake harbors is not reasonably practicable. The true policy for lake shipbuilders and owners is to build ships to suit the waters they must sail in, and not to waste great sums in futile efforts to keep open channels of great depth in persistent opposition to the forces of nature.

As noted in the July number, one vessel—the *E. C. Pope*—recently delivered in Cleveland 2,741 tons of ore on 14 ft. 1 in. draft; and the same ship can carry over 3,000 tons on 16 ft. draft. With ships so designed and built it would seem that the necessity for 20 ft. channels, difficult to secure and impossible to maintain, hardly existed. The Lake shipowners ought to be well satisfied with the performance of their vessels. If financial results are unsatisfactory it is usually in years of comparatively light business, when rates are reduced below the paying point by reckless competition; and for this they have only themselves to blame.

NEW RAILROAD CONSTRUCTION.

THE amount of new railroad built is always regarded as a kind of barometer showing the general condition of the railroads. To some extent this is true, but it is more expressive of general financial conditions than of the special state of the railroads. At any rate, it is of considerable importance to know what is being done in this direction, and the work of collecting statistics has been undertaken by several of our contemporaries, with results that vary to a somewhat surprising extent. According to the figures collected by the *Railway Age*, which seem to be the most precise and reliable, the total length of new track laid in the six months ending with June—the first half of 1891—was 1,728 miles on 139 different lines. This is a greater mileage than might have been expected, as financial conditions have not been favorable to the building of new lines this year, and very little in the way of extension has been done by the older companies. The indications seem to be that the total new mileage for the year will be over 4,000 miles, and may reach 5,000.

The new building has been pretty well distributed, and has been mainly in short lines or sections. Very little has been done in the West or Northwest, the South continuing to lead, as it did last year. The new mileage in the Southern States was 713, or about 40 per cent. of the total.

Six States added over 100 miles each to their railroads. In Georgia 174 miles are reported; in Pennsylvania, 139; In Washington, 135; in Alabama, 120; in South Carolina, 107; and in Virginia 105 miles. In New York only 2½ miles were built.

The situation at present is that the new building is almost entirely of local lines in settled districts, and that the building of competing and paral'el lines is entirely at a standstill.

CAR-WHEEL GUARANTEES.

AT the annual meeting of the Master Car Builders' Association held last year, a Committee was authorized to consider the report of the meeting of the Association of Manufacturers of Chilled Car Wheels, held November 21, 1889, in New York City. At this meeting the manufacturers adopted the following resolutions:

That when wheels are taken out of service on account of *sharp flanges, flat spots, comby* or *shelled-out treads*, or for *cracked brackets* or *plates*, and it is found on breaking up the wheels that the depth and character of the chill and the strength and character of the metal in the plates are up to the standard specifications adopted by the Joint Conference Committee of the American Railway Master Mechanics', the Master Car Builders' and the Wheel-Makers' Associations, it shall be considered that the failure is due to the service and not to the quality of the wheel, and that the wheel-maker ought not to be called upon in such cases to pay for or replace any such wheels.

To this proviso of the Wheel Manufacturers, the Committee of the Car Builders' Association object, on the ground, first, that it is indefinite, and, second, that its provisions would virtually put the wheel-makers in a position in which they could refuse to replace any wheels; and the Committee then give their reasons for their objections. On another page we publish a communication from Mr. Griffin, the well-known wheel manufacturer of Buffalo, in which he has put in some arguments in rebuttal of the position taken by the Committee.

It is one of those cases in which each count should be considered separately. First, then, should a wheel-maker be required to replace a wheel which fails on account of a sharp flange?

The causes assigned for sharp flanges are: 1, varying sizes of wheels on the same axle; 2, trucks out of square; 3, unequal wear of wheel. With reference to the first cause, the Committee say that "in our opinion" mismating of wheels is now a rare occurrence. Mr. Griffin, on the other hand, says it is a very common one, and that many car-builders will not take the trouble to mate wheels. With reference to the second cause, the Committee say that "our observation would imply that it is not active in producing worn flanges, because if it was it would produce worn flanges on both pairs of wheels." Is this true? If the axles in a truck are not parallel, one of them might be square and the other not, and then one of the wheels on the axle which is not square would probably get a sharp flange, whereas those on the square axle might not be worn. There are also other defects in construction which might cause sharp flanges, such as the center-plates being out of center on the truck or car-body, the draw-bars out of the center line of trucks. It is easy to imagine, too, defects in the suspension links, which would cause the truck to bear more against one flange than against the other.

The Committee say, "in our opinion the difference in the wearing qualities of the two wheels on the same axle is the cause of nearly all flange wear." The fact, though, that the average mileage of wheels which fail on account of sharp flanges is high, is very strong presumptive evidence against this "opinion." If wheels got sharp flanges on account of their poor wearing qualities, their average mileage would not be high, because they would wear out in the tread before making a high mileage, as all poor wheels do. The fact that a wheel makes a high mileage before its flange wears sharp indicates that it has good wearing qualities, and therefore that it is not the lack of such qualities that has caused the flange to wear sharp. If poor wearing qualities were the chief cause of sharp flanges, then the average mileage of such wheels would be low, whereas a study of any wheel report will show that while the average mileage of wheels with worn flanges is not as high as the best wheels, it is nevertheless very good.

For these reasons, if we were called upon to act in the capacity of a judge in this matter, we would decide that if the mileage of a wheel with a sharp flange has exceeded 20,000 miles that the maker ought not to replace it.

As to flat spots, the Committee say, and it is agreed, that there is no question about the responsibility for flat spots produced by sliding, when the cause is apparent; but there are flat spots which are due to defects in the wheel. This is also true of "comby" or "shelled-out treads." These defects, in the opinion of wheel-makers and car-builders, are sometimes a *consequence* of sliding the wheels, but they are also at times due to faults in the castings. The charge of indefiniteness which the Car Builders' Committee make to this provision of the wheel-makers is, it is thought, sustained. The difficulty will probably be to determine whether the defects named are due to misuse or to faults in the metal or the casting of the wheels. A more careful diagnosis of these disorders, with more explicit and definite statement of their symptoms, will probably be the only way by which the responsibility for them may be determined. Concerning "flat spots," the Committee say that "if a proper depth of white iron existed, the wheel would not wear flat;" but the wheel-makers will probably retort they nevertheless do wear flat when there is a proper depth of white iron, and therefore conversely, when there is the proper depth of white iron the wheel-makers ought not be held responsible, which is all they ask.

Regarding comby or shelled-out treads, the Committee and Mr. Griffin seem to hold diametrically opposite opinions, and we know of other wheel-makers and some car-builders who agree with him. The Committee hold that these defects "are entirely due to the quality of the wheels, and are not caused under any circumstances by improper treatment of the railroads," whereas Mr. Griffin holds that "they can be caused by brake-service." A commission of wheel doctors should consider and report on these disorders.

Regarding cracked brackets the responsibility is not so clear. Undoubtedly they are at times, as the Committee say, the result of brittleness in the iron or improper design in the pattern, but it is also true that they are often a consequence of overheating by long application of the brakes. Ordinarily it would not be easy to determine which is the cause. We are inclined to believe that the wheel-makers will be obliged to assume the risk of this defect, because few railroad officers would be willing to assume the responsibility of using wheels which are liable to crack under any kind of usage.

NEW PUBLICATIONS.

THE MICHIGAN ENGINEERS' ANNUAL. *Containing the Proceedings of the Michigan Engineering Society for* 1891. (F. Hodgman, Secretary, Climax, Mich.)

This number of the *Proceedings* contains several excellent papers presented before the Society by members. Among these may be included one by Mr. Hodgman on the Ownership of Lake Beds; one by Mr. Muenscher on Easement Curves; one by Mr. Teed on Engineering for Lumbermen, and several others of merit. It is well for engineers to have this and similar volumes, for much of the best work of our engineers is contained in them, and they often present valuable records of experience which may be of service in similar cases elsewhere.

A convenient appendix to the volume is a compendium of recent decisions in land cases, of interest to surveyors. The volume is well printed and remarkably free from typographical errors, which are so apt to creep into technical work.

THE LOGARITHMIC SPIRAL CURVE. By William Cox.

THE POLAR PLANIMETER: A MANUAL. By William Cox.

THE SLIDE RULE. By William Cox. (The Keuffel & Esser Company, New York.)

These are three useful monographs. The first describes the manner of constructing the logarithmic spiral and the various uses to which that curve can be put in an engineer's work, in finding the value of proportions, determining centers of curvature, drawing curves, etc.

The second monograph is a description of the polar planimeter and the various methods of using it. This instrument is almost indispensable to engineers, who so often have to ascertain quickly the areas of irregular surfaces. It is an exceedingly ingenious instrument, and its convenience can only be fully appreciated by those who have used it.

The third is a book of 30 pages, in which are described the various uses of the slide rule—an instrument which is, perhaps, more often talked about than used; at any rate, it is not as frequently used as it ought to be. Especially intended for engineers, it is really convenient for every one who has measurements and calculations to make, and that would include almost the whole community. This little book gives one an idea of the various uses to which it can be put; its explanations are generally clear and brief. The only change to be suggested is that it would have been convenient to have such a manual of pocket size.

THE HISTORY AND DEVELOPMENT OF STEAM LOCOMOTION ON COMMON ROADS. By William Fletcher, M.E. (E. & F. N. Spon, New York and London; 288 pages, 108 illustrations.)

This book presents in one volume, for the first time, we believe, a complete history of the various efforts—both successful and unsuccessful—to apply steam as a motor on common roads. The author claims to have made a complete history, and his claim is good so far as the early history of the subject goes, and so far as English practice is concerned; but it is somewhat defective on what has been done outside of England. The book is well arranged and pretty fully illustrated, but it would have been much improved by a complete index.

It is divided into seven sections: Introduction; the Period of Speculation; the Period of Experiment; the Period of Successful Application; the Modern Period; Design and Construction of Road Locomotives; (English) Traction Engine Law.

Mr. Fletcher has done a service in collecting and arranging the history of this subject in a convenient and accessible form, and for this we can pardon him for making too much use of manufacturers' catalogues and circulars in his chapters on modern practice. The book is worth reading and preservation.

MANUAL OF THE RAILROADS OF THE UNITED STATES. By Henry V. Poor. (H. V. & H. W. Poor, New York.)

It is not an easy matter to criticise the yearly volume of *Poor's Manual*. It is not only the best work of the kind we have, it is the only one, and it is quite indispensable for those who are connected with railroads or interested in railroad securities. Nowhere else can such a mass of information be found, and its long period of existence and high standing have given it almost the authority of an official work. Certain defects it has, some of which are unavoidable, from the way in which its information is collected; but there is no doubt that the publishers spare no pains to keep it up to a high standard and to make it as complete and as correct as possible.

The *Manual* for 1891 contains over 1,400 pages, and gives reports and statements of 835 railroad companies in the United States and Canada; there are also reports of a number of equipment, terminal and other auxiliary companies, and summaries for a large number of street railroad companies. How complete the statistics collected are is shown by the fact that in the Introduction the total railroad mileage in the United States is given at 163,420 miles, while the figures given for operations cover 157,976 miles, while the mileage not covered is chiefly of short and unimportant lines, or of new railroads lately brought into operation.

In the Introduction there is a valuable summary of railroad operations for the year, which gives almost the only general view we have of railroad conditions and progress. Some figures from it will be found on another page.

A TREATISE ON THE CALKINS STEAM-ENGINE INDICATOR. *With Description of Calkins' Improved Graduated Pantograph, Polar Planimeter, Speed Measure, Revolution Counter, Parallel Rule, Indicator Spring, Weighing Device, Mercurial Column.* (New York; E. & F. N. Spon.)

The title of this book describes its general character. It contains a very full description and illustrations of the Calkins Indicator, with directions for its use. In the latter part tables and units of various kinds are given, which are useful in connection with the application of the indicator. Directions are also given for calculating the power of an engine from the diagram, for computing the amount of steam used, the duty of boilers, and general remarks on the several lines of indicator diagrams.

The book is well printed and illustrated, and will be an excellent guide to the application of the indicator.

CAR LUBRICATION. By W. E. Hall, B.S., M.E. (New York; John Wiley & Sons.)

Probably few practical railroad men will read the title of this book without some degree of eager anticipation. It relates to a subject which is a never-ending source of annoyance and expense on railroads, and for that reason they are naturally anxious for any information which would help to lessen the annoyance or reduce the expense. It is to be feared, however, that when they read in the introduction that "the object of the following chapters will be, pure and simple, to reduce the conditions to a relationship the nature of which will assist toward reducing this expenditure, either directly or indirectly, to the lowest attainable figure," they will wonder what it all means. Imagine, too, a busy superintendent who has been troubled with hot-boxes turning to this book to learn of a remedy, and encountering on the sixth page the following formula:

$$L = \int^{+} P\, l\, R \cos. \omega\, d\omega$$

to determine the pressure upon a given surface of the journal. The whole subject is discussed on scientific stilts, and quite over the heads of the large number of people to whom a book of this kind written in a clear and simple style would be useful. A critic of railroad literature often wonders at the blindness of many authors who write for railroad men. It may safely be

said that there are some thousands of people in this country who would be interested in a good book on the subject of Car Lubrication which they cou'd understand. Presumably the book before us was intended to sell yet it is written in a style which will be incomprehensible to nine-tenths or more of the people who, if they could understand it, would be most interested in it and would be possible buyers of it. This shows a lack of the business sense, which is the more flagrant because the value of the book would not be diminished but increased, even for the most highly educated understandings, if it was written on a lower plane and in a more simple form. Much of the explanation is harder to understand than the thing explained. The following is the formula given to determine the cost of lubricating one journal:

$$2.617\frac{d}{d'} \cdot C\,c\,J\,T + B\,b + O\,o + A\,a + W\,w = M.$$

The subjects treated of in the different chapters are Theoretical Relations, Coefficient of Friction, Bearing Metals, Methods of Lubrication, Journal-box Construction, Cost of Lubrication, and Heated Journals.

Chapter III contains a brief *résumé* of the experiments of Tower and Woodbury, which is useful; but probably practical men will search in vain through the pages of the book for directions to guide them. It is without any index or even a table of contents, which is an unpardonable fault.

TRADE CATALOGUES.

Price-List No. 8, July, 1891, of the Phosphor-Bronze Smelting Company, Limited. Philadelphia, No. 512 Arch Street.

Few people not especially familiar with the business appreciate the variety of uses to which phosphor-bronze, as made by this company, is now put. An examination of this price-list shows prices for various sizes and weights of phospher-bronze in sheets and rolls; wire, both coarse and fine; wire specially made for telegraph and telephone lines; wire ropes; wire cord; special ropes for power transmission; special ropes for rigging and for steering apparatus; wire cloth; tacks, nails and boat spikes; rolled and cast pump rods; rolled and cast bolts, nuts and washers; wood screws of all sizes; sash chains; bars and rods; split links; pens, for writing; hammers, chisels, scissors, wedges, wrenches, and other special tools for use in powder mills and magazines; valves, cocks and similar work. These are the ordinary lines, and do not include the great variety of castings made, such as bearings, gear wheels, pumps, screw propellers and others, for which the varieties of this metal are specially adapted.

Revised Price Lists of the Link Belt Engineering Company. Philadelphia and New York.

This price list shows a great variety of applications of this company's link belting for various purposes, such as in paper-mills, saw mills, foundries, elevators, and almost all kinds of factories. The company also makes numerous attachments of various kinds for use in connection with its belts. It has recently been enabled also, by improvements in its factory, to make a notable reduction in prices of most of its chains.

Catalogue of the Ferracute Machine Company, Bridgton, N. J. No. 6. Assorted Presses.

This is received too late for comment, except to say that the company is now getting out a new series, which we hope to notice at length.

The Pelton Water Wheel and Water Motor: Illustrated Circulars. The Pelton Water Wheel Company, San Francisco.

Compartment Water Heaters and Condensers, and Artificial Water Coolers: Illustrated Catalogue. Klein, Schanzlin & Becker. Frankenthal, Rhenish Bavaria, Germany.

TECHNICAL SCHOOLS.

An addition to the article on this subject in the last number of the Journal is made necessary by the receipt of additional catalogues and other documents. It may perhaps be well to note here that this article was not intended to be a list of all the technical schools, but simply a notice of those catalogues and prospectuses which had accumulated on the editorial desk.

As many of our readers doubtless know, the Massachusetts Institute of Technology, in Boston, is one of the oldest and largest of the institutions of this class, and is probably the best equipped. Opened in 1865, it has had the benefit of more than 25 years' experience, and it has gradually been built up into what might be called an industrial university, with a large teaching staff and excellent appliances. Its organization and methods have served as models for several later schools.

As shown by the latest catalogue, there are now 12 regular courses in the Institute; these are: 1. Civil and Topographical Engineering. 2. Mechanical Engineering. 3. Mining Engineering and Metallurgy. 4. Architecture. 5. Chemistry. 6. Electrical Engineering. 7. Biology. 8. Physics. 9. General Course. 10. Chemical Engineering. 11. Sanitary Engineering. 12. Geology. With the use of optional studies, these courses can be enlarged and diversified, enabling the student to cover a wider range of instruction than is comprised in a single course.

The latest addition made is the Engineering building, which, to describe it briefly, is a structure 148 × 52 ft. and six stories high. It contains recitation rooms, drawing rooms, the library for the Civil and Mechanical Engineering departments, and four laboratories, one for experimental work on strength and other properties of materials; a laboratory of steam engineering; a hydraulic laboratory, and one where other experiments are made. The building itself is intended as an example of the latest and best methods of building mills and of fire-proof or slow-burning construction.

BOOKS RECEIVED.

Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending March 31, 1891. Washington; Government Printing Office.

The Carolo-Wilhelmina Ducal Technical High-School at Brunswick: Programme for the Study-Year 1891–92. Brunswick, Germany; issued by the School. We have before referred to this school, which holds a high rank in Germany.

Experiments in Aerodynamics. By Professor S. P. Langley. Washington; the Smithsonian Institution. This book comes to hand too late to receive in the present number the attention which its importance deserves.

Annual Statements of the Railroad and Canal Companies of the State of New Jersey for the Year 1890. Trenton, N. J.; State Printers.

Tabellen zur Berechnung der Flächeninhalte, der Terrainbreiten und der Böschungsbreiten, der Querprofile bei Wege und Grabenbauten: by Friedrichsen, Royal Surveyor. R. Von Decker, Berlin, Germany. This is a very complete set of earthwork tables, accompanied by diagrams and formulas. The explanations, etc., are, of course, in German, and the tables follow the metrical system of measurement.

Massachusetts Institute of Technology: Annual Catalogue, 1890–91. Boston; published by the Institute.

A Technical Description of the Engineering Building of the Massachusetts Institute of Technology. Boston. This is a reprint from the *Proceedings* of the Society of Arts connected with the Institute.

Transactions of the Technical Society of the Pacific Coast, January–June, 1891. San Francisco; published by the Society. This number of the *Transactions* contains several valuable papers.

Occasional Papers of the Institution of Civil Engineers. London, England; published for the Institution. The papers included in the present installment are the Counterbalancing of Locomotives, by Edmund L. Hill; the New Nadrai Aqueduct, by William Good; the Sewerage of Dudley, by E. D. Marten; Petroleum Storage Installations, by R. Pickwell; Irrigation in Southern California, by W. Fox; Electric Mining Machinery, by L. B. Atkinson and C. W. Atkinson; Abstract of Papers in Foreign *Transactions.*

ABOUT BOOKS AND PERIODICALS.

A PAPER on Glass in Science in the POPULAR SCIENCE MONTHLY for September completes the series on Glass Making, by Professor Henderson, and describes the methods of making thermometer tubes, hydrometers, lenses for telescopes, etc. Mr. Garrett P. Serviss submits some arguments on the question of whether we can always count upon the Sun. Other papers are by Professor John Fiske, Dr. Andrew D. White and Herbert Spencer, making a number of solid interest and value.

Among the more important articles in SCRIBNER'S MAGAZINE for September are Mr. Ricalton's account of some of the little-known monuments of antiquity found in Ceylon; Mr. Spears' paper on Odd American Homes, and Professor Royce's on University Life. In the Steamship Series, Lieutenant Hunt furnishes the closing article, which is on the Steamship Lines of the World, including a sketch of the possibilities of travel now open to the voyager with time and means.

A new weekly electrical paper has been started in Chicago. It is called ELECTRICITY, and will present the popular side of electric matters for the general reader rather than the specialist. The first numbers contain some excellent articles well illustrated, and the managers are evidently determined to deserve the success which we hope they will secure. The paper is very attractive in appearance, and is worthy of attention from all who are interested in electricity—and that includes a great many people now.

In the number of HARPER'S WEEKLY for August 5 there is an illustrated account of the Naval Reserve drills at New York. The Boston drills had been described in a previous number. The number for August 19 discusses the Chilian question at considerable length. In that for August 12 Lieutenant-Colonel W. R. King discusses the measures to be taken for the defense of New York against a hostile attack.

The TECHNOLOGY QUARTERLY for August has the Commencement address of the President of the Massachusetts Institute of Technology. Mr. C. Frank Allen writes of a Course of Instruction in Railroad Management, and there are several articles of special technical interest.

Very few American readers are able to take the foreign magazines, but many would like to follow the general current of foreign thought and writing. For such readers there can be nothing better than the old-established ECLECTIC MAGAZINE. The range it presents is well shown by the August number, which contains articles from 16 different English periodicals, nearly all the leading ones, the choice including a variety of more serious articles and of lighter reading.

A new monthly paper called the COMPASS has been started by the Keuffel & Esser Company, New York, under the editorship of Mr. William Cox. It is proposed to make this a useful companion for the engineer, treating each month of new instruments for field and office work; principles of the construction of instruments; descriptions of new works, and other items. The first number has 16 pages, about the size of *Harper's Magazine*, and contains some excellent reading; it promises well for the future, and the new venture should be a successful one.

In the August number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE there are articles on the Inter-Continental Railroad; China's First Successful Railroad; Controlling the Mississippi; Our Physical Geography; the Northern Limit of Mankind, and others on a variety of topics. This magazine aims at condensation, and its articles are generally short, bright and readable; many of them really conveying a great amount of information in a small space.

In HARPER'S MAGAZINE for September, Montgomery Schuyler's Glimpses of Western Architecture are continued, this second paper treating of the domestic architecture of Chicago. There is another chapter of the history of London, and an excellent historical article on the New York Chamber of Commerce. This issue is notable for the number and variety of the illustrations.

The paper of most interest to railroad men in the ARENA for August is "Should the Nation Own the Railroads?" by C. Wood Davis. There are several others which every one who thinks and who believes in the progress of the human race should read. This magazine is above all one for thoughtful people, and never fails to have articles which will at least interest, even if they do not convince such readers.

The man—or woman—who is in search of outdoor recreation for a summer or fall vacation cannot do better than to read OUTING for August. Its contents are varied, and almost every article is of interest to the general reader, whether he takes to any special form of sport or not. This magazine has improved very much of late in the quality of its illustrations, and has also increased their number.

In the OVERLAND MONTHLY for August will be found an exceedingly interesting article on Gold Mining of To-day. Some comments on the Relief Map of the Pacific Region, with an engraving of the map, give a better comprehensive idea of the topography of the Pacific Coast than anything we have ever seen. This magazine is valuable to any reader who wants to know what is going on upon the Pacific Coast, and this gives it a special interest apart from its general literary excellence.

NOTES.

THE previous record for fast trips across the Atlantic was broken in August by the *Majestic* and the *Teutonic*, both of the White Star Line. The fastest previous voyage had been made by the *City of Paris*, of the Inman Line. The *Majestic's* trip was made in 5 days, 18 hours, 8 minutes; the *Teutonic's* in 5 days, 16 hours, 31 minutes. In both cases the weather was favorable. The two trips and that of the *City of Paris* may be compared in the following table, which shows the daily runs:

Knots run on	*Teutonic.*	*Majestic.*	*City of Paris.*
First day	460	470	432
Second day	496	501	493
Third day	505	497	502
Fourth day	510	501	506
Fifth day	517	491	509
Sixth day	290	317	346
Total	2,778	2,777	2,788

On the *Teutonic's* trip the average speed was 20.35 knots an hour, with 80 revolutions of the screws and 180 lbs. boiler pressure. The consumption of coal was about 300 tons a day.

SOME experiments in electric lighting have recently been made by the Safety Electric Light Company, of Boston, whose system has been put on a parlor car of the New York & New England Railroad. The company uses a primary battery, and the trials are said to have been very successful so far.

THE INTER-CONTINENTAL RAILROAD.

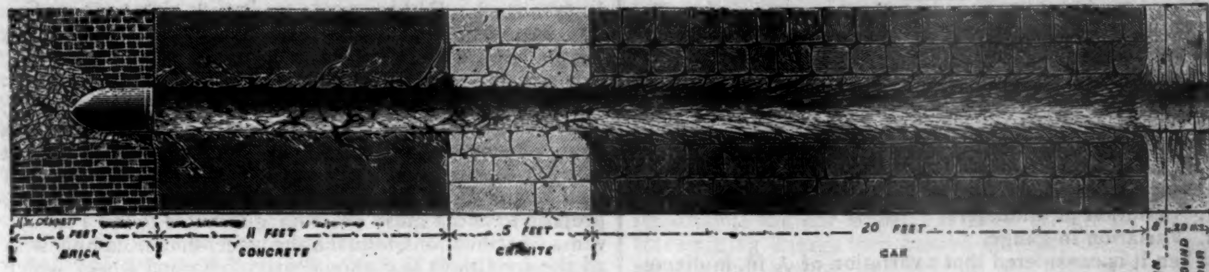
(From *Goldthwaite's Geographical Magazine.*)

THE International American Conference, which was held in Washington over a year ago, appointed an Inter-Continental Railroad Commission to take in charge the preliminary steps toward the great project of connecting North and South America by a railroad. The Commission has been in session in Washington this year, and before its adjournment until February next, it appointed three surveying parties to go to various portions of the proposed route, make the preliminary surveys, and decide upon the practicability of the undertaking. Word has been received that these parties have reached their destinations, and it is expected that they will return to this country with their reports in a little over a year.

The first report of the Commission has been submitted to the Secretary of State. It outlines the proposed route of the great railroad. A line of railroad, it says, is projected, and has been surveyed from the City of Mexico to Ayutla, on the frontier of Guatemala. From Ayutla the proposed line runs parallel with and not far from the Pacific coast through Mazatenango to Santa Lucia, thence by Cuajiniquilapa to Santa Anna in Salvador. Then the line turns rather abruptly east away from the Pacific, through Nuevo San Salvador and San Miguel to Goascoran in Honduras. From Goascoran the line will skirt the head of the Gulf of Fonseca, through the State of Choluteca to the city of the same name; thence the line passes through Chinadega in Nicaragua to Rivas on Lake Nicaragua, and along the west shore of the lake through Alajuela in Costa Rica, and on through San Jose to Puerto Limon, on the Carribbean Sea. This is the only place where it touches Atlantic waters.

Thence it passes down the Isthmus of Panama to the valley of the Atrato, where the isthmus joins South America. In Colombia the line will cross the western cordillera of the Andes into the valley of the River Cauca, and up this valley to Popayan. A branch road will be run from the main line east to the city of Bogota. From Popayan, the line will cross the mountains a little west of south to Pasco near Ecuador, and will thence continue through by the cities of Tulcan, Ibarra, Quito, Cuenca and Loja and into Peru, running through Ecuador, west of the main cordilleras. Through Peru, the route, as laid down on the map, will pass through the provinces of Cajamarca and Amazonas, and across formidable mountain ranges to the River Maranon, the head waters of the Amazon, and through its valley to Cerro de Pasco; thence the route will pass along the River Perene and on to Santa Anna, thence to Cuzco, Santa Rosa Puno, on the west side of Lake Titicaca, where the railroad will connect with the Pacific line, terminating in the port of Mollendo. Then the road will continue down the west side of Titicaca to the Bolivian frontier, and, on its way south, will pass through the cities of La Paz and Oruro to Huanchaca. Here the main line terminates at 20° S. latitude, and west southwest of Potosi. From Huanchaca trains will reach Chili, the Argentine Republic, Paraguay and Uruguay by branch lines. Venezuela will be connected with the trunk line by a branch from some suitable point in the valley of the Cauca to Medellin, where it will connect with an existing railroad to the city of Puerto Berrio, on the Magdalena River, and continue through Bucaramanga, San Jose de Cucuta, and Merida to Valencia.

We probably shall not hear very much more of this project until the reports of the parties that are making the preliminary surveys are received. Not a few men who are more or less familiar with most of the regions to be traversed are exceedingly sanguine that favorable reports as to the practicability of the railroad will be made. It is certain that among the cordilleras of Colombia and Ecuador enormous difficulties must be overcome, and the railroad will be a most extensive enterprise, whose cost will perhaps not be justified by the commercial results for many years to come. There can be no doubt, however, of the ultimate carrying out of this project, and it is a wise and far-seeing policy to take hold of the great project now with a view to ascertain the financial burden it will involve, the engineering difficulties to be met, and the best means of making it a reality.



PENETRATION OF A SHOT FROM THE ARMSTRONG 110-TON GUN.

WHAT THE 110-TON GUN CAN DO.

THE accompanying illustration and description are taken from an account of the exhibit made by Sir W. G. Armstrong, Mitchell & Company in the Naval Exposition in London, given in *Engineering*. Referring to the 110-ton gun, it says:

The full charge of this weapon is 960 lbs. of brown prismatic powder, which costs $400; and the steel projectile weighs 1,800 lbs. and costs $425. This makes a total of $885 (including small items, such as fuses, etc.) for each round with full charge and armor-piercing shot. The life of a 110-ton gun is put down at 75 rounds with full charges, while that of the 67-ton gun is 120 rounds. The wear and tear occasioned by the full, three-quarters and half-charges may, we are told, be considered to be in the proportion of three, five and ten; thus the 67-ton gun could fire 400 half-charges or 200 three-quarter charges, while the 110-ton gun could fire 250 half-charges or 125 three-quarter charges. It is obvious that full charges are to be sparingly dealt in with these costly weapons, and it is equally obvious that there is no need to do otherwise than deal sparingly with them in peace operations, and perhaps, too, oftener in war operations than one is generally apt to imagine.

It will be remembered that the 110-ton gun firing a 1,800-lb. projectile with 960 lbs. of powder had a muzzle velocity of 2,105 ft. per second, the total energy being 55,305 foot-tons. The figures are sufficiently impressive to those sufficiently accustomed to such matters to grasp them, but the Elswick authorities have rightly concluded that it would bring the matter much more closely home to the ordinary exhibition visitor were there put forward a graphic delineation of what the 110-ton gun can do. They have, however, had made full-sized and very realistic drawing of the course through a target of the projectile fired from the *Sanpariel's* 110-ton gun on March 14 last. The illustration given is taken from a photograph of this graphic delineation of the power of the monster gun. The shot met first of all a 20-in. compound armor plate. At the

back of this was an iron backing plate 8 in. thick which was fastened to a heavy wrought-iron frame. Beyond was built up a structure consisting of solid oak balks. These occupied a thickness of 20 ft. Next came 5 ft. of granite, and beyond that was 11 ft. of concrete. Finally there was 5 ft. of brickwork. The shot struck fairly in the center of the plate, traveling at a velocity of 2,079 ft. per second. It went through both plates, then in turn through the 20 ft. of oak, the 5 ft. of granite, and the 11 ft. of concrete, and was finally brought up by the bricks at the end, although it forced out a large wedge of brickwork, and almost got through.

CAR-WHEEL GUARANTEES.

By P. H. Griffin, President New York Car-Wheel Works.

Referring to the Report of the Committee on Wheel Guarantee as submitted to the Master Car Builders' Convention, in June, 1891, at Cape May, N. J., I have to state some facts on the subject that have been developed by a very careful study of the cause of flange wear in particular, and the causes of wheel failure in general.

The causes of flange wear as apparent to me are given in the order of prominence :

1. Variation in diameter.
2. Variation in gauge.

When it is considered that a variation of $\frac{1}{16}$ in. in diameter between two 33-in. wheels on an axle would cause the larger one to travel *ten feet* farther in one mile if it could, and that the greater the load the more certainty of quick destruction from such a condition, there is little mystery about the main reason for flange wear or why it has increased of late years with the higher speeds and greater loads.

The M. C. B. rules accept wheels pressed on axles with a variation of ¼ in. from gauge.

It is the rule in many shops to press both wheels on an axle at the same time, and to work the wheel-press at a very rapid rate to save time. This causes imperfect conditions that must produce extra friction, undue wear, and poor service. The second cause may help to counteract the first in one case, and in the opposite will double the rapidity of failure on account of flange wear.

The Committee state that, in their opinion, mismating at the present day is a rare occurrence. On what premises is that opinion based ? As a result of inspection of wheels fitted to axles or not ? Of course any railroad man would promptly say that his wheels were properly mated ; but how many can show a careful inspection of wheels before fitting them to axles to see that uniform diameters go in pairs ? How many railroad shops have any appliances for making such a test ? How many builders of freight cars give the matter a thought ? Some car-wheel makers tape and stencil all wheels for diameter ; but it is not required that they do so as a rule, and when done there is not much attention given by the wheel fitters to the verification of the marking as being correct. We gauge our wheels by sixty-fourths of an inch diameter, and find considerable trouble in getting users of them to put like numbers on same axles ; they say it is too much bother. It is not difficult to prove the facts, however. At any railroad shop or along the line will be found many pairs of wheels fitted to axles ready for service. Any one interested can test them and see what the average result is. It may be found far from the condition indicated by the report of the committee.

The conditions of the present day are referred to as an improvement on those of the past ; but what change has been made in the average practice in fitting up chilled wheels except, perhaps, to turn out a greater number daily with the same plant ? The work used to be done years ago by mechanics, the quantity required was smaller, and the time spent upon it was greater ; two cuts were taken out of the wheel to insure accuracy. Now the work is done in many car and repair shops by laborers more or less skilled ; whether the wheel hubs are hard to bore or not, the daily "stint" must be kept up, and the result cannot be toward a higher standard.

The Committee give as their opinion that "the difference in the wearing quality of two wheels on one axle is the cause for nearly all flange wear, and for this wear the wheel-makers should be held responsible."

If the Committee is correct in their finding, why is not the proposition of the wheel-makers a fair one ?—viz. : that "Wheels failing for sharp flange should be broken, and if the depth and character of chill are up to the standard specifications adopted by the Master Mechanics' and Master Car Builders' Associations, then the wheel-maker ought not to replace the wheel."

It is very easy to determine whether a wheel is properly chilled or not. A piece can be broken out of the flange with a small sledge and without handling the wheel at all. The M. C. B. Specifications were taken almost literally from the Pennsylvania Specifications, and the intent of both is to insure that wheels of proper chill and strength be furnished. If they are so furnished, is it fair to stipulate that wheel-makers be responsible for failures due to causes beyond their control ?

It must be remembered that the Pennsylvania Specifications do not require the wheel-maker to give a guarantee ; the wheels are rigidly examined before being accepted, as being of proper strength and chill, and as to being perfect in other details. Once accepted on these conditions, that is the end of it. The M. C. B. Specifications, however, propose to add a most exacting guarantee to the Pennsylvania Specifications to make the wheel-maker comply with all the conditions that should exist in a good wheel, which is all right, and then to make him assume responsibility for the results of conditions of service over which he has no control ; that is all wrong.

The Committee state that as to "flat spots" they understand the term to mean wheels having spots on them which have worn through the chill, and "that at this spot an inspection would show that a proper depth of white iron did not exist." Well, if it did exist, what then ? Presumably the wheel could not be classed as a failure. The Committee go on to state that "shelled out" treads are entirely due to the quality of the wheel, and are not caused under any circumstances by improper treatment of the railroads.

The knowledge and experience of many railroad men will bear me out in the statement that "flat spots" and "shelled out" spots can be caused on all well-chilled wheels by brake service ; and it is simply a question with a well-chilled wheel whether it is removed soon enough after brake sliding has occurred to prevent shelling out, or whether it has been run for long enough time to cause the iron (burned by friction at the flat spot) to shell out under pressure of load carried of from three to six tons with a corresponding blow on the wheel 300 to 600 times in every mile traveled.

The finding of the Committee on cracked brackets and plates is correct in the main, as good wheels will undoubtedly give better results in this particular than poor ones ; but their statement that "with good wheels it is safe to say that for every wheel that fails in this way twenty pass the ordeal successfully and fail from finally wearing out." What about that one good wheel ? Was it a failure for which the wheel-maker should be responsible ?

Sufficient consideration has not been given this wheel question in respect to the radical changes in the speed and load of trains that have been made in the last ten or fifteen years. Every advance in that direction imposed greater duties on the wheels. Brake service of to-day does not much resemble that of ten years ago. Freight cars are being equipped with air brakes, and passenger and freight trains weighing from 500 to 1,000 tons are run at speeds varying from 30 to 60 miles per hour on the presumption that they can be promptly stopped when necessary. The wheels must furnish the means of doing that through the medium of the brakes. Is it fair to ask wheel-makers to be responsible for the results of such vital changes as these ? When the engineer has the power to apply instantly a force of 25 tons air-brake pressure per car on wheels loaded with a weight of three to five tons each and revolving at from 300 to 600 times per minute, what must

be the result? No metal will stand such treatment without damage; yet the Committee say that defects arising from such a service "are entirely due to the quality of the wheel, and are not caused under *any circumstances* (the italics are mine) by improper treatment of the railroads."

It is a well-known fact that cracked plates are caused entirely by brake service, mainly on high grades. Many railroads without excessive grades have no trouble of this kind, and other roads with high grades remove thousands of wheels annually for this cause. It occurs more frequently in freight service, and is caused by the fact that brakes must be set on the cars on heavy down grades to prevent loss of control over the train. Brakemen have orders to set them moderately on a number of cars, but to save time and trouble, set them excessively tight on a few cars—often merely set the brakes on the caboose and one or two cars adjoining, and allow the train to run down a long grade in this manner. The wheels are bound to heat up, and where brakes are tightly set on long grades, it is almost impossible to prevent plates cracking from expansion. In fact, any wheel can be cracked in the plates in this way if the application is continuous and severe enough. Is it fair to return wheels ruined in this way to the wheel-maker, and refuse an investigation as to whether they were of proper quality? If the railroads must save the loss arising from such a condition, they should do it through attention to the brakes. If the latter were lightly set on a greater number of cars, or if the application was changed from one car to another, so as to prevent excessive heating, the damage would not be done.

Railroad managers buy steel wheels at from six to eight times the net cost of chilled wheels, and without question assume the expenses for wear attributable to brake service. They buy costly lathes; and if steel wheels are slid flat or run to sharp flange they are removed and the tire turned down without a thought of the maker being responsible. The total mileage obtained from steel wheels is always referred to as if it were obtained without constant labor and expense in refitting and returning the tires to obtain it.

No one believes that the M. C. B. Association or any other body of railroad men intend to impose unfair conditions on any one, or that even if they did so from a misapprehension that they would continue to enforce them.

The subject of chilled wheels is one that is not understood as it should be, and there is no one cause as distinctly responsible for the lack of knowledge as the guarantee. It would appear, on the face of the matter, that railroads would be benefited by a practice that enabled them to buy supplies without investigation of quality or character—to do business, as it were, under "bond and mortgage." Had there never been a guarantee, had railroads bought car wheels as they do other material, more attention would have been paid to the subject, and better information would have been gained as to what a chilled wheel is, what it should do, and what it cannot do; then there would have been more progress in fitting it for the increased demands of to-day.

This has not been the case, however. In the main, orders have been placed with the lowest bidder because he would give *a guarantee;* that such a manufacturer can change his business arrangements as often as he chooses, and is in no way really bound to his promises, does not seem to affect the case. The responsible manufacturer must meet the same conditions or lose business. What is the result? The majority of railroads in this country are putting wheels under their cars to-day that do not net the makers *one and one-half cents per pound.* These figures include all scrap values for old wheels returned, and represent the total net price received by the maker for his wheels. Well, it may be possible that wheel-makers are alchemists and can furnish proper wheels at such prices, but it is not likely. Why should this be the case? It is not fair to say that wheel-makers are responsible for this condition as a body because a certain number among them have helped to create it. It is all very well to say that they should not sell wheels unless they can get a price that admits of furnishing good ones; but when their very best customers—the leading railroads of the country—tell them they must meet competition or lose the business, what is to be done? It is doubtful if a body of men can be found who have worked harder, have really done more in any one thing to enable the wonderful economy of American railroad practice than the practical car-wheel makers of this country. As a rule, they are men who commenced at the bottom and worked up; so have the majority of the men with whom these practical questions must be settled. It cannot be that either body wants anything unfair of the other. Certainly the wheel-makers have reached a point where they cannot go farther. It is useless to impose more exacting conditions on them than they now labor under. To tell them that no allowance has been or will be made for the increase in service their wheels must give, consequent on the double speed and double load of to-day as against that of 10 or 15 years ago, cannot be the intention of any committee or association.

The proper solution of this question is to leave it in such shape that investigations will be made. No other course will determine the good and the bad.

The drop test proposed as a part of the wheel specifications can be used precisely as well on wheels worn out as on new wheels; and it is surely not too much to ask, and no fair-minded railroad man will refuse to investigate alleged failures before saying to the wheel-makers that they must throw away time and money fairly rendered simply on the ruling of the Association and without any investigation of the facts.

Of all the various parts of a car, not one approaches in importance the car wheel. It must do all the work of transmitting energy into motion to move the load and of transferring motion into friction and heat to stop it. It must do this while sustaining the load. It must perform these services with the temperature at 20° to 30° below zero, or at 90° to 100° above. There is hardly a strain, or shock, or blow that can be imagined that a car wheel does not have to stand, and yet these are only the outward and recognized tasks imposed on it. With every movement the small but never-ending shock and blow of service must affect its body. What we know as motion is simply an infinitely multiplied movement, and the greater the motion the greater the movement. If car wheels simply transmitted motion, that would be a different thing, but multiply that service by the load carried, and that product by the energy that is constantly transferred into heat with brake service, and an idea can be gained of what a car wheel must do.

The chilled wheel is expected to pass from the foundry as a rough and unfinished casting and give results that can be obtained from the most costly steel wheels upon which all mechanical art can do has been done regardless of expense.

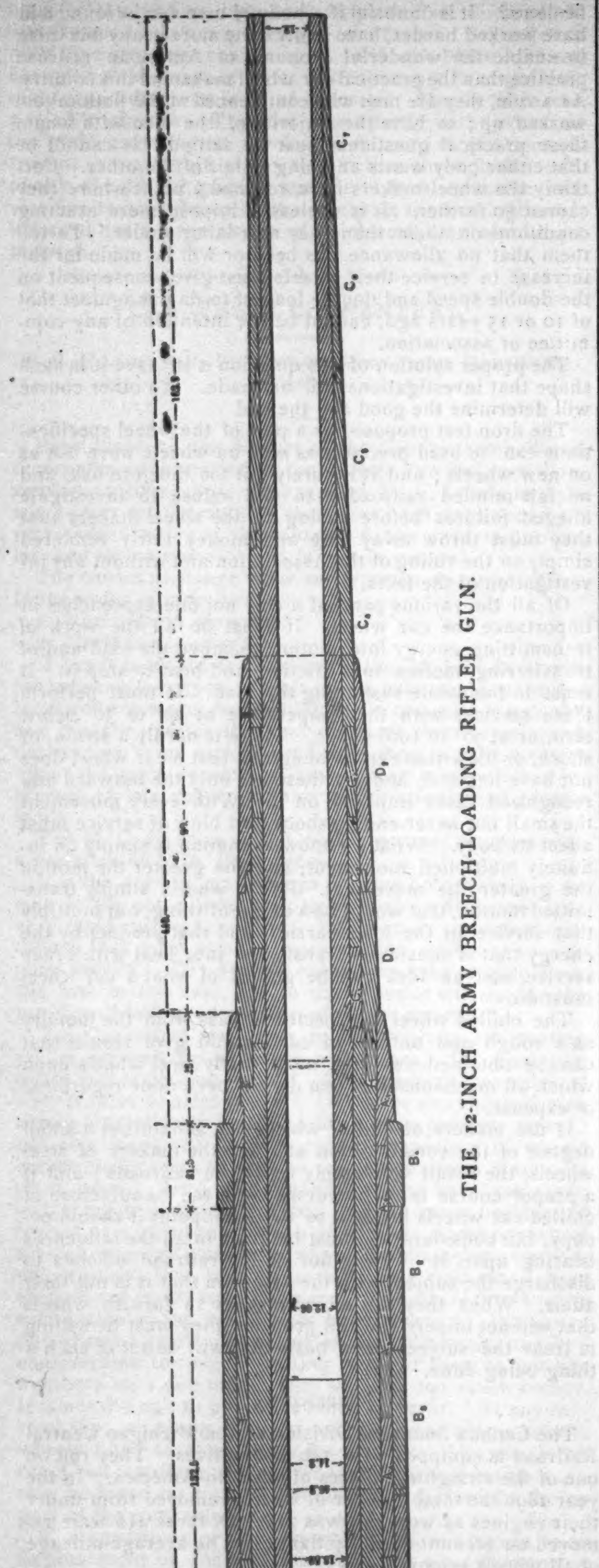
If the makers of chilled wheels can obtain but a small degree of the consideration afforded the makers of steel wheels, the result will amply repay the railroads; and if a proper course is to be pursued and the manufacture of chilled car wheels brought to the standpoint it should occupy, fair consideration must be given to all the influences bearing upon it. It will not do for railroad officials to discharge the subject with the assertion that it is not their affair. When they ask wheel-makers to furnish wheels that will not imperil life and property, they must be willing to treat the subject on a basis that will admit of such a thing being done.

APPENDIX.

The Canada Southern Division of the Michigan Central Railroad is equipped with 119 locomotives. They run on one of the straightest pieces of track in America. In the year 1890 the total number of wheels removed from under their engines as worn out was 728. Of these 416 were removed on account of sharp flange. The average mileage of all wheels removed was:

	Worn out from			
33 in.	Sharp flange,	65,730.	Other causes,	58,522.
30 in.	" "	53,670.	" "	53,772.
28 in.	" "	59,030.	" "	60,430.

The following individual cases of mileage of wheels ultimately failing from sharp flange indicates that as a final cause of failure flange wear is the question to be met:



THE 12-INCH ARMY BREECH-LOADING RIFLED GUN.

Failed account sharp flange.

Rem'v'd in Jan., 1891, from Engine No. 410,	2 28-in. Trk. whls.—121,373 m.
" " " " " " " 405,	2 30-in. Tdr. " —123,093 m.
" " " " " " " 378,	2 30-in. Tdr. " —108,434 m.
" " Dec., 1890, " " " 364,	2 30-in. Tdr. " —118,116 m.
" " Nov., 1890, " " " 357,	2 30-in. Tdr. " —100,741 m.
" " Oct., 1890, " " " 419,	2 33-in. Tdr. " —119,937 m.
" " " " " " " 385,	2 30-in. Tdr. " —103,177 m.
" " " " " " " 349,	2 28-in. Trk. " —132,231 m.
" " " " " " " 349,	2 28-in. Trk. " —102,730 m.

As a remarkable fact, nearly all of the wheels making over 100,000 miles ultimately failed on account of flange wear. This proves that the conditions causing flange wear are not necessarily associated with poor wheels.

THE ARMY 12-INCH GUN.

THE accompanying illustration, for which we are indebted to the courtesy of the *Iron Age*, shows a longitudinal section of the new 12-in. army breech-loading rifled gun. One of these guns—the first of a number now under construction—is now undergoing its trials at the proving ground at Sandy Hook.

This gun was built at the Watervliet Arsenal, West Troy, N. Y., where a large and well-fitted plant has been established for building guns. A noteworthy fact is that when the construction of this gun was authorized it was not possible to obtain steel forgings of the requisite size in this country, and therefore the tube and jacket were made by Whitworth, the hoops being of home material, and all of the work being done in the Watervliet shops. So rapid has been the growth in the steel works in this country that the material for the guns now under construction, and for those which may be ordered in the future, will all be furnished by home concerns.

The new gun is of the built-up type; it weighs 52 tons, is 12 in. in bore and 440 in. long over all. The outside diameter at the muzzle is 20¼ in., at the trunnions 47.8 in., and at the breech 46.2 in. The exterior diameter of the tube at the muzzle is 17.4 in., and at the breech 22 in.; the jacket being 33.54 in. in diameter and 174 in. long.

This gun and the 13-in. navy rifle are the largest guns of modern type yet undertaken here. Probably these sizes will not be exceeded for service guns, though a 15-in. or 16-in. experimental gun may be built hereafter.

THE HOLTON BASE.

By Professor J. Howard Gore.

WHEN the Kent Island base-line, near Baltimore, was measured several decades ago, it was not thought probable that its accuracy would receive a test at a point more than 500 miles to the westward; nor, in fact, did any one at that time suppose that a triangulation within this century would extend half so far from the eastern shore. The Kent base served as the foundation of a strong chain of triangles which were projected along the general trend of the coast—far enough back to rest on elevations of requisite heights for suitable length of triangle sides, yet sufficiently near to furnish frequent checks for the triangulation of shorter sides on which the shore topography and offshore hydrography could rest. To do work of this kind was the original function of the Coast Survey. But when these chains of primary triangulation assumed greater proportions it became apparent that they could be put to use in contributing geodetic data, and as soon as this idea attained its proper hold on the legislative mind the Coast Survey became the Coast and Geodetic Survey. In planning the work for this reorganized institution a transcontinental chain was decided upon, and work was soon begun along the 39th parallel. In course of time several independent parties were put in the field to measure bases at somewhat regular intervals, and to extend the triangulation east and west from each of these until the intervening gaps are filled, and thus the entire chain completed. Those who are familiar with the care and accuracy with which the officers of the Coast and Geodetic Survey do

their work will realize what a huge undertaking this has been, and all who are interested in the exact sciences will fully appreciate its importance.

That portion of this arc known as the eastern section has been from its inception in the hands of Assistant A. T. Mosman. He took as his starting line one of the lines of the Atlantic coast chain which rested on the Kent Island base. None but those familiar with this class of work and the rough character of those portions of Virginia, West Virginia, Ohio, Kentucky, and Indiana, through which this portion of the arc passes, can form a just conception of the enormity and variety of difficulties which confronted Mr. Mosman in the prosecution of his labor. The reconnoissance has been exceedingly difficult, especially in those localities where hills of nearly the same height abound, or in lower lands which are heavily timbered. The next segment of this arc, in charge of Assistant G. A. Fairfield, has its base near the Missouri River, and in the 250 miles of its eastward course passes over a low country where hills of sufficient height are wholly lacking, and signals to be seen must be from 100 to 150 ft. high. These two sections of arc meet on a common line in Southern Indiana, and being an element in two independent chains, this line has two values. If the county surveyor is anxious until he finds that his latitudes and departures balance, what must be the feeling of suspense as the computations for the lengths of a junction-line approach completion—especially when the bases are nearly 1,000 miles apart, with an intervening chain representing almost a score of years!

As could be expected, when the reputation of the two chiefs is considered, the rough computation for the lengths of this line in common gives results which are in wonderful accord. But in order to properly distribute the slight discrepancy, it was deemed advisable to measure a new base near the junction. This is the Holton base, situated near Holton, Ripley County, Indiana. Numerous bases have been measured in various parts of this country, and the bibliography of the subject covers many pages; but it is safe to predict that in varieties of methods, ingenuity of devices, and elaboration of results, none will equal Holton base. The mere determination of the length of the base within the usual limits of accuracy would be quite a simple operation, but its favorable location suggested that some of the theoretical features connected with base-line work might here be subjected to practical tests, so that the Holton base not only enters as a factor in the transcontinental chain, but it takes, as an experimental base, a most important place in the history of Geodesy.

First of all comes the measurement with a modified form of the secondary apparatus, in which a single bar of steel forms the measuring element. The changes in the way of improvements are in the direction of securing more accurate temperature determinations, and more reliable data for making corrections for inclination. This measurement is under the immediate supervision of Assistant O. H. Tittmann, whose Colorado base forms a part of this arc. Two measurements with this apparatus will give all that is demanded even by the exacting conditions of a geodetic arc. But in order to apply a crucial test to the claims of those who insist that tape-line measurements can be made with all needful exactness and in less time, extensive preparations have been undertaken for measuring this base with tapes of steel and of bronze, singly and conjointly, supported and unsupported, and of different lengths. The details have received most careful attention, and so far give evidence of a complete mastery. Tension along the tapes is under control, and the dreaded question of temperature no longer appears formidable.

In all linear determinations the uncertainty as to the length of the unit employed while in actual use has caused the greatest concern. This is particularly the case when long tapes are used. But in the present case that uncertainty becomes a vanishing quantity. Very near the base a 100-meter comparator has been constructed, on which it is possible, through an intermediary five-meter bar compared with the metric prototype, to lay off points whose distance apart is any distance desired. These transfers are made under conditions exactly similar—the go-between in both cases being surrounded by ice. From a number of measurements, lengths of 25, 50 and 100 meters are laid off on this comparator, then the tapes are applied, and from oft-repeated observations at various temperatures their exact lengths are ascertained. Then, too, all the data essential for the determination of coefficients of expansion are in hand, together with the requisite information regarding the effect of coiling and uncoiling on the length of the tape. From this it can be seen that the tapes are most carefully compared with a reliable standard and under conditions similar to those which will prevail during the actual measurement of the base. These tapes will be used repeatedly in ascertaining the length of the entire base, and the results will doubtless go far toward settling the question as to what shall be used hereafter in measuring bases.

In order to institute still further comparisons, and to test the absolute accuracy of the various methods of measuring, one kilometer of the base will be measured with the same bar, in ice, which was compared with the prototype. This bar is a line measure, and must, therefore, be passed successively under microscopes, two and two; and to secure reliable results, great stability of microscopes is absolutely necessary. To secure this, the inventive genius of Assistant R. S. Woodward, who is in charge of this special investigation, has found ample play. During a sojourn of three months on the ground, daily using various parts of the apparatus, and comparing them with other forms which I have employed before, I have found much that was unique and original, and still more that gives promise of yielding results far in advance of anything of its kind ever attempted before.

The entire work is under the direction of Mr. Mosman, whose name, to the gratification of his friends, will always be associated with the Holton Base—a work which will soon be known throughout the world.

THE ENGINES FOR THE NEW BATTLE-SHIPS.

THE accompanying drawings show the engines designed by the Bureau of Steam Engineering, Navy Department, for the new battle-ships now under construction. These ships have been heretofore described, but for convenience of reference their main dimensions are here repeated: Length, 348 ft.; breadth, 69 ft.; mean draft, 24 ft.; displacement, 10,000 tons. They have a heavy water-line belt of armor, and will carry a very heavy armament. The engines are described as follows in the report of Engineer-in-Chief George W. Melville:

These ships are designed for a cruising speed of 15 knots and are to be propelled by machinery capable of developing, when forced 9,000 H.P., and under ordinary conditions, 8,000 H.P., driving twin screws.

The main engines are inverted, vertical, direct-acting triple-expansion, with cylinders of 34½ in., 48 in., and 75 in. in diameter, and 42 in. stroke, and it is estimated that at a piston speed of 900 ft. per minute or 129 revolutions, the I.H.P. will be 9,000.

Each engine and its auxiliaries will be separated from the other by a fore-and-aft water-tight bulkhead, so that in case of accident to one engine the other would not be affected.

The main valves will be of the piston type, worked by Stephenson double-bar links; one valve for each high-pressure cylinder, two for each intermediate, and four for each low-pressure cylinder, the diameter of all the valves being 17 in.

The intermediate and low-pressure cylinders are steam jacketed at sides and bottom; the high-pressure ones have linings, but are not jacketed. The framing consists of an inverted Y-column at the back of each cylinder and two forged steel cylindrical columns at the front. The engine bed-plates will be of cast steel supported on wrought-steel keelson plates which are built in the ship.

The piston-rods, valve stems, and all working rods are to be of mild forged steel; the pistons will be of cast steel.

The crank-shafts will be of mild forged steel; they will be made in three sections which will be reversible and

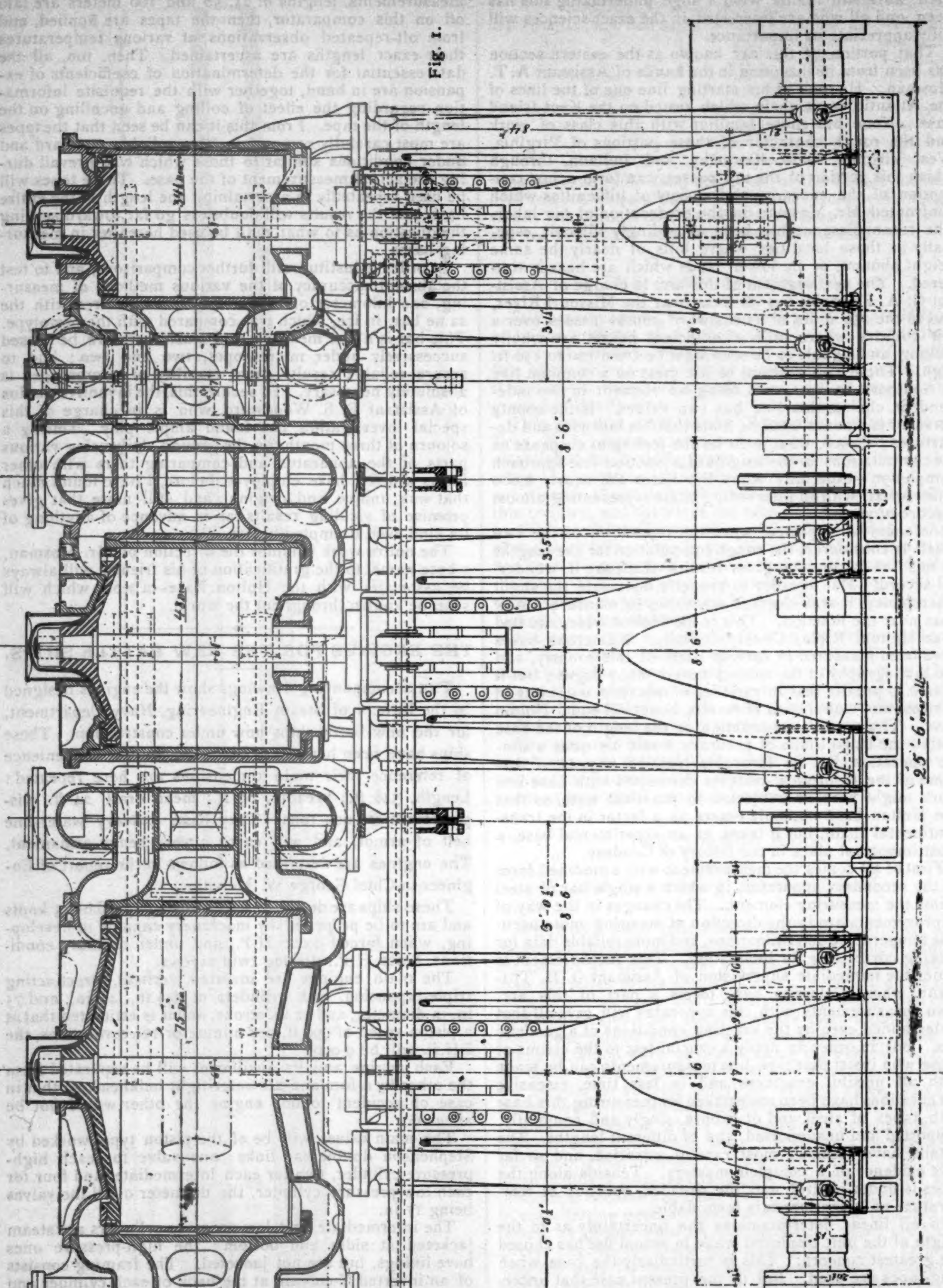


Fig. 1.

ENGINES FOR COAST LINE BATTLE-SHIPS NOS. 1, 2 AND 3, U. S. NAVY.

DESIGNED BY THE BUREAU OF STEAM ENGINEERING. GEORGE W. MELVILLE, CHIEF OF BUREAU.

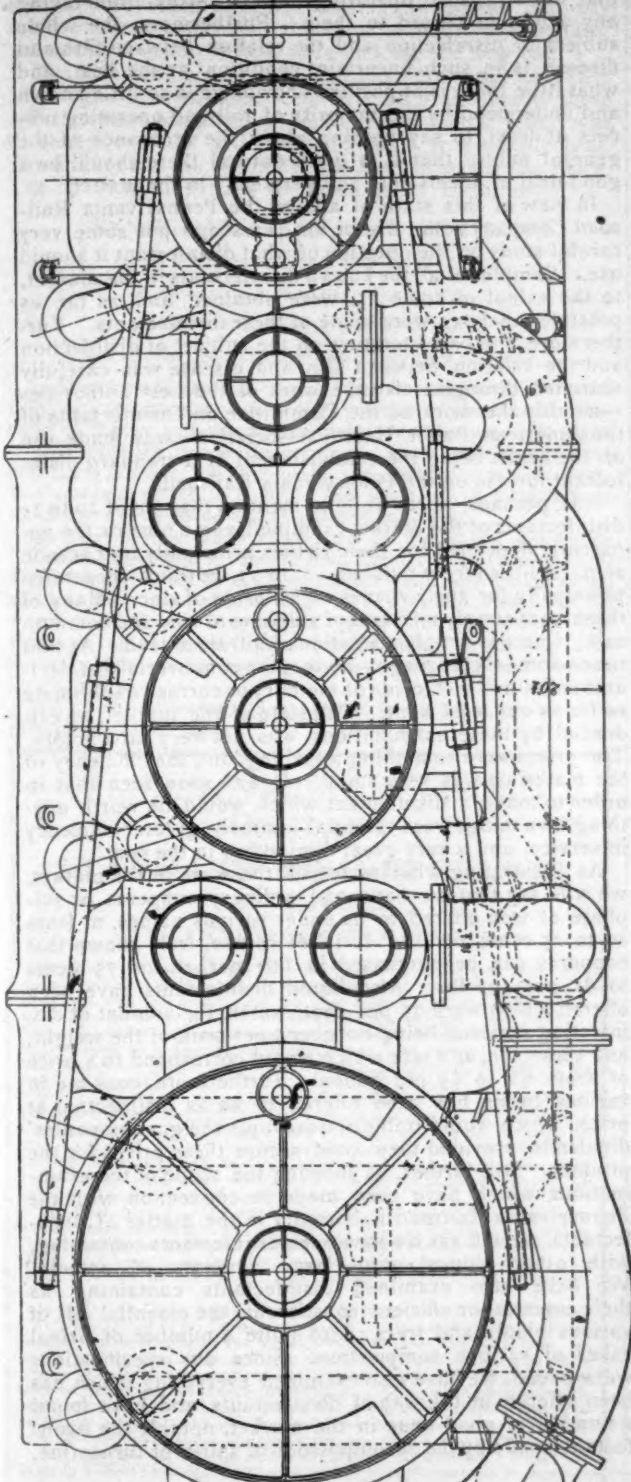


Fig. 2.

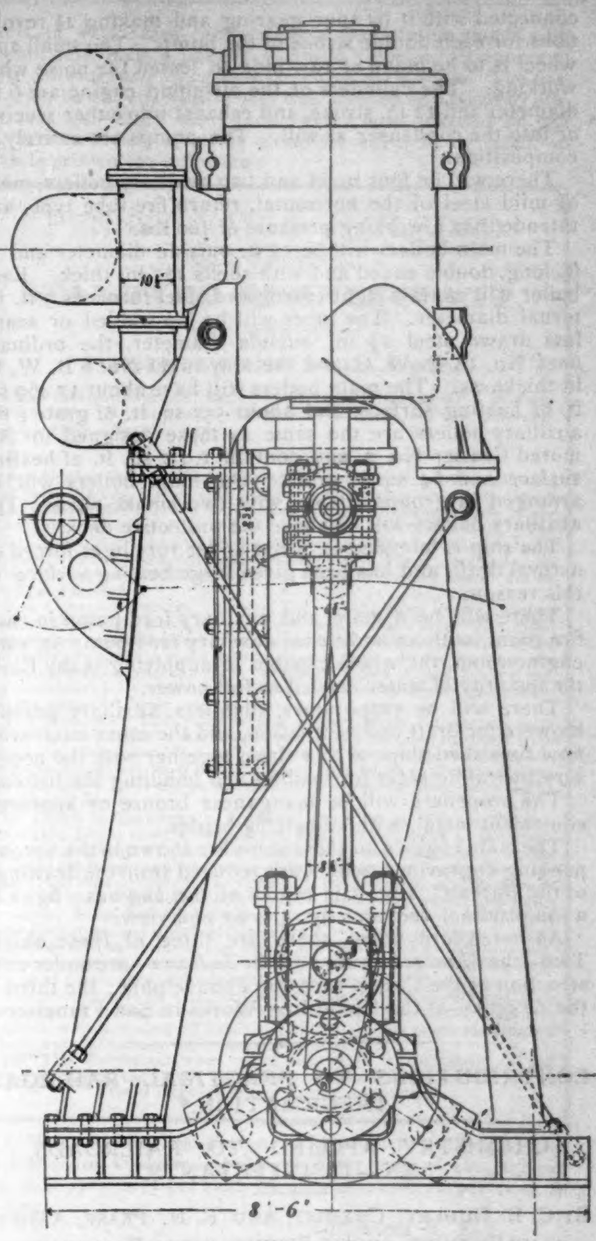


Fig. 3.

interchangeable with each other and with those of the other engine. They will be 14 in. in diameter in the journals and 15 in. in the pins, and have axial holes of 6 in. in diameter through the former and of $6\frac{1}{2}$ in. through the latter.

There will be a separate condenser for each engine, made with cast-brass heads and rolled-brass shell, bolted and riveted together. The castings will be $\frac{7}{16}$ in. in thickness and will contain all the nozzles for steam and water openings. The shell will be $\frac{1}{4}$ in. thick, butted, strapped, riveted and soldered together. The diameter will be 5 ft. 9 in., and length between tube sheets 10 ft. 3 in. Each condenser will contain 3,788 seamless drawn brass tubes, $\frac{5}{8}$ in. outside diameter, giving 6,353 sq. ft. of cooling surface of the outside.

Condensing water will be supplied each condenser by a centrifugal circulating pump capable of discharging 9,000 galls. of water per minute from sea or bilge.

The air-pumps for each engine will be two vertical, single-acting, lifting pumps of 20 in. diameter and 18 in. stroke. Owing to the difficulty which has been experienced in running the air-pumps at low speed when the rods are directly attached to the engine driving them, the Bureau has designed this pump to be driven by an engine to be

connected with it by spur gearing and making $2\frac{1}{4}$ revolutions for each double stroke of the pump. The small spur wheel is to be made of raw hide to lessen the noise when working. The cylinders of the air-pump engine are 6 in. diameter and 12 in. stroke, and exhaust into either receiver or into the condenser at will. The pumps are entirely of composition.

There will be four main and two auxiliary boilers, made of mild steel of the horizontal, return fire-tube type, and intended for a working pressure of 160 lbs.

The main boilers will be 15 ft. outside diameter and 18 ft. long, double ended and with shells $1\frac{19}{64}$ in. thick. Each boiler will contain eight corrugated steel furnaces 3 ft. internal diameter. The tubes will be lap-welded or seamless drawn steel $2\frac{1}{4}$ in. outside diameter, the ordinary ones No. 12 B. W. G. and the stay tubes No. 6 B. W. G. in thickness. The main boilers will have about 17,460 sq. ft. of heating surface, and about 552 sq. ft. of grate; the auxiliary boilers are the same as those designed for Armored Cruiser No. 2, and contain 1,937 sq. ft. of heating surface and 64 sq. ft. grate. The main boilers will be arranged in groups of two, with two smoke-pipes. The auxiliary boilers will be above the protective deck.

The ship is intended to cruise under very light forced or natural draft, and has been given large heating surface for this reason.

There will be a main and auxiliary feed-pump in each fire-room, with an additional auxiliary feed-pump in each engine-room, the whole capable of supplying many times the quantity of water needed at full power.

There will be evaporators, distillers, auxiliary pumps, blowers for draft and ventilation, and the other auxiliaries now furnished ships of this class, together with the necessary hydraulic plant for loading and handling the battery.

The propellers will be manganese bronze or approved equivalent metal, with adjustable blades.

The main engines for these ships are shown in the accompanying engravings, which are reduced from the drawings of the Bureau. Fig. 2 is a plan of the engines; fig. 1 is a longitudinal section; fig. 3 is an end view.

As heretofore noted, there are three of these ships. Two—the *Massachusetts* and the *Indiana*—are under construction at the Cramp yards in Philadelphia; the third—the *Oregon*—at the Union Iron Works in San Francisco.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.
XX.—DISINFECTANTS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 321.)

Perhaps no question is more annoying or perplexing to the ordinary railroad operating officer than the question, "What disinfectant shall be used?" and this perplexity arises from several sources. In the first place, there is very great need many times of something that is efficient and quick in its operation, which will remove bad odors; also the papers are full of articles in regard to health and disease, and each railroad operating officer feels more or less that there may be danger lurking everywhere which he hardly knows how to meet except by means of disinfectant. On the other hand, the ordinary disinfectants which are found in the market are so clothed in mystery and high-sounding names, and the prices are so appalling, that most railroad operating officers shrink from taking any action in regard to them. Furthermore, the whole subject of disinfection and the relation between filth and disease is in such uncertain condition at the best, and what little there is of positive knowledge is so little known and understood by the majority of railroad operating officers at least, to say nothing about the ignorance of the general public, that it is quite natural there should be a good deal of uncertainty and perplexity in the matter.

In view of this state of affairs, the Pennsylvania Railroad Company some five or six years ago put some very careful study on the question of what disinfectant it should use. Samples of all the known disinfectants in the market, to the extent of some 25, were obtained, and, as far as possible, analyses were made of these disinfectants. Furthermore, the best literature on the subject of disinfection and the relation between filth and disease was carefully searched through; also the work of the best authorities—notably the work of the Committee on Disinfectants of the American Public Health Association—was made use of, the result being the establishment of a standard disinfectant for use on the Pennsylvania Railroad.

It is, perhaps, worth while to mention that out of 20 to 25 disinfectants of the market examined, some nine or ten apparently depended for their virtues principally on carbolic acid. A little larger number—12 or 13, we think—depended principally for their virtues on chloride of zinc. Many of these were simply mixtures of sulphate of zinc and common salt. One was simply a solution of nitrate of lead. At that time—some six years ago—none of the commercial disinfectants contained bichloride of mercury or corrosive sublimate so far as our tests went. The state of the market, as evidenced by these examinations, was not very satisfactory. The prices were something appalling, and the efficiency of the materials was very small. It was soon seen that in order to make a disinfectant which would be worth anything, two things were essential—namely, greater efficiency in service, and a very great diminution in the cost.

As illustrating what materials there are in the market, we will say that we have had ordinary copperas or sulphate of iron offered to us under various names, at from 10 to 25 cents per lb. It is, of course, well known that copperas can be purchased in the market for 75 cents to $1 per 100 lbs. Also liquid disinfectants have been offered which were 95 per cent. water, the amount of disinfecting material being not over 5 per cent. of the weight, and these, too, at a rate which would correspond to a price of from $2 to $5 per gallon. Furthermore, coal tar in various forms has been offered to us as disinfectant at prices which would treble or quadruple the gas companies' dividends, provided they could secure these prices for the product. Still further, as showing the scope of the examinations which have been made in connection with the Pennsylvania Railroad Laboratory in the matter of disinfectants, we will say we have seen disinfectants containing, with other things, quite large amounts of arsenic. We have also examined disinfectants containing as their essential or efficient constituents the essential oils of various plants and trees; also quite a number of urinal cakes of various composition. Since our specifications were issued, we have also examined everything which has been offered in the way of disinfectants, and have found a number of good ones in the market, notably the disinfectants made by the decomposition of spirits of turpentine,

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the Journal for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these Contributions to Practical Railroad Information of special value in indicating the true character of the materials they must use and buy.

but in general we have found these materials either to be not as efficient as our own standard disinfectant, or that the prices render their use in comparison with our own unwise. It is always our policy to examine every new disinfectant which appears; and if we should find any more efficient or cheaper than our standard disinfectant, we would abandon ours at once and use the new one.

Our first disinfectant specifications were dated February 28, 1885. The disinfectant made in accordance with these specifications contained no bichloride of mercury, and was in reality more of a deodorant than a true disinfectant. Since that time the specifications have been revised twice. The latest specifications are given below, as follows:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

No. 27.

SPECIFICATIONS FOR DISINFECTANT.

(*Superseding Specifications dated February* 28, 1885.)

I. Disinfectant for the use of the Pennsylvania Railroad Company will consist of a neutral solution of the normal chlorides of copper and zinc and mercuric chloride, put up in eight (8) ounce bottles, and securely corked. Each bottle should contain 2,400 grains of zincic chloride, 120 grains of cupric chloride, 10.5 grains of mercuric chloride and ten drops of a mixture of equal parts of terebene and spirits of turpentine.

II. The bottles used should be of the shape known as "Round Prescription," should hold slightly more than eight (8) fluid ounces, should be made of Amber Glass, and should weigh not less than 3,500 grains each. They should also have the words "P. R. R. Disinfectant" blown in the glass. The Pennsylvania Railroad Company has a mould for making these bottles which is at the service of parties desiring to fill orders for disinfectant.

III. Each bottle must have pasted to it a label, on which is printed the following:

PENNSYLVANIA RAILROAD COMPANY.

STANDARD DISINFECTANT.

DIRECTIONS FOR USE.

For Use on Cars.—Empty the contents of this bottle into about one quart of water. With sponge or waste, wash with the liquid all parts of the urinal, seat and hopper, and the floor adjacent to them in the closet, allowing some of the liquid to run down the urinal pipes. The same solution should be used on the floors and woodwork of the whole car, whenever washing with disinfectant is necessary. The carpets and plush of an infected car should not be treated with disinfectant, but should be fumigated instead.

For Cleaning Privies, Closets, Etc.—Empty the contents of this bottle into about one quart of water and use as above. The disinfectant acts slowly on lead, tin, copper, brass, iron, etc., and it is not advisable to allow it to stand in the basins or traps. In the vault, use the disinfectant full strength, not less than half a dozen bottles at once, but it is better to disinfect privy vaults with crushed sulphate of copper, or chloride of lime, sprinkled freely over the mass.

For Removing Bad Odors.—Empty the contents of this bottle into about one quart of water, and sprinkle the liquid in the place from which the odors arise, also saturate a towel, or other fibrous substauce, with the liquid and hang it in the place from which it is desired to remove the odors. For use on towels, etc., a disinfectant without color can be furnished if desired.

In Cases of Diphtheria, Scarlet, Typhoid and Typhus Fevers, Cholera, Dysentery, Consumption, Etc.—Place a little of the disinfectant, full strength, in the vessel which receives the excrement, or vomit, or throat discharge, and pour more of the disinfectant on the discharge after it has been received in the vessel. If the discharge soils the floor or furnitute wash these soiled spots with the disinfectant mixed with water, as above. Soiled bed and body linen, rags or handkerchiefs used to receive discharges, and soiled clothing should be burned, or soaked in disinfectant diluted as above, for four hours, and then rinsed with water.

For the Dead, where Disinfectant is Necessary.—Wrap the body in a sheet thoroughly saturated with the disinfectant full strength.

For Attendants on the Sick.—Empty the contents of this bottle into a pint of water, and wash the hands, and other portions of the body, if soiled, with it, rinsing off with clean water. In sick rooms and hospital wards, wash all surfaces with the same solution.

☞ This disinfectant, when mixed with water, as described, will not injure the hands, but should not get into the mouth.

IV. Shipments of Disinfectant in bottles which show less than eight (8) fluid ounces per bottle, or which yield on analysis less than twenty (20) per cent. by weight of zinc, one (1) per cent. of Copper, twenty-three (23) per cent. of Chlorine, and 0.14 per cent. of mercury, will be rejected.

V. The standard Disinfectant may be ordered and shipped in barrels, in which case each gallon of the solution should contain not less than 4 pounds of zincic chloride, 3.2 ounces of cupric chloride, and 149 grains of mercuric chloride. The barrels must be of good quality and well hooped and glued to prevent leakage. They must each have a label fastened on one end, best by means of strips along the edges of the label, on which is printed the following:

PENNSYLVANIA RAILROAD COMPANY.

STANDARD DISINFECTANT.

DIRECTIONS FOR USE.

Draw the disinfectant from the barrel by means of a wooden spigot only. Metal cocks should not be used, as the disinfectant slowly corrodes them.

For Use on Cars.—Mix a quart of the disinfectant with seven and a half pints of water. Then with sponge or waste, wash with the liquid all parts of the urinal, seat and hopper, and the floor adjacent to them in the closet, allowing some of the liquid to run down the urinal pipes. The same solution should be used on the floor and woodwork of the whole car whenever washing with disinfectant is necessary. The carpets and plush of an infected car should not be treated with disinfectant, but should be fumigated instead.

For Cleaning Privies, Closets, Etc.—Mix a quart of the disinfectant with seven and a half pints of water, and use as above. The disinfectant acts slowly on lead, tin, copper, brass, iron, etc., and it is not advisable to allow it to stand in the basins or traps. In the vault use the disinfectant full strength, not less than a half gallon at once, but it is better to disinfect privy vaults with crushed sulphate of copper, or chloride of lime, sprinkled freely over the mass.

For Removing Bad Odors.—Mix a quart of the disinfectant with seven and a half pints of water, and sprinkle the liquid in the place from which the odors arise: also, saturate a towel, or other fibrous substance, with the liquid, and hang it in the place from which it is desired to remove the odors. For use on towels a disinfectant free from color can be furnished if desired.

In Cases of Diphtheria, Scarlet, Typhoid, or Typhus Fevers, Cholera, Dysentery, Consumption, Etc.—Place a little of the disinfectant, full strength, in the vessel which receives the excrement, vomit, or throat discharge, and pour more of the disinfectant on the discharge after it has been received in the vessel. If the discharge soils the floor or furniture, wash these soiled spots with the disinfectant mixed with water as above. Soiled bed and body linen, rags or handkerchiefs used to receive discharges, and soiled clothing should be burned, or soaked in disinfectant diluted as above for four hours, and then rinsed with clean water.

For the Dead, where Disinfectant is Necessary.—Wrap the body in a sheet thoroughly saturated with the disinfectant, full strength.

For Attendants on the Sick.—Mix a quart of the disinfectant with two quarts of water, and wash the hands and other portions of the body, if soiled, with it, rinsing off with clean water. In sick rooms and hospital wards, wash all surfaces with the same solution.

☞ This disinfectant, when mixed with water, as described, will not injure the hands, but should not get into the mouth.

Empty Barrels Need Not be Returned.

VI. Shipments of Disinfectant in barrels will not be accepted which show on analysis less than 15.8 per cent. of zinc, 0.8 per cent. of copper, 0.13 per cent. of mercury, and 18 per cent. of chlorine.

Theodore N. Ely,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., March 6, 1891.

It will be observed that our disinfectant practically consists of a mixture of chlorides of zinc, of copper, and of mercuric chloride, with a little terebene and spirits of turpentine. The reasons why for each of these constituents is as follows: The mercuric chloride or corrosive sublimate is, as far as we know or are able to get information, the most efficient material which can be used for general disinfecting purposes; and, as will be observed by the directions which go on the bottle, the material, when diluted for use, is about one part in 2000 mercuric chloride. When the disinfectant is used full strength, as provided for in the directions, the proportions of mercuric chloride are one part in 500, and when diluted for use by attendants on the sick the proportions are one part in 1000. This makes a very efficient disinfectant, if we may trust the results of the work of the Committee on Disinfectants of the American Public Health Association.

The chloride of copper is, perhaps, anomalous as a disinfectant, since we are unable to find any experiments which show that chloride of copper as such is a very efficient disinfectant. Sulphate of copper is known to be thoroughly efficient, but the chloride has apparently not been experimented with so much. The use of chloride of

copper in our disinfectant was to get something to fix sulphuretted hydrogen, which is one of the gases often given off from decaying organic matter, and also, if possible, to get a little chemical action due to some base acting as a carrier, with the idea of consuming or burning the organic matter with which the substance came in contact. It is well known that oxide of iron freshly precipitated is a very efficient means of burning or slowly consuming organic matter with which it is in contact, provided the organic matter is either suspended or dissolved in water. But it was impossible to use any iron salt in our disinfectant on account of the serious stain to everything with which the disinfectant came in contact, as well as the difficulty of keeping the disinfectant unchanged by time. We accordingly introduced a little copper. The sulphate would not stay as such in a solution of chlorides, so we were compelled to put in a little chloride of copper. It is well known that copper in presence of sulphuretted hydrogen becomes sulphide of copper, and that sulphide of copper in presence of air oxidizes to sulphate; also that sulphate of copper may again precipitate as sulphide, and thus a series of changes be kept up which it was hoped would result in the decomposition of the organic matter. We are not able to say that this point has been thoroughly proven, and our main reliance, so far as the copper salt is concerned, is on something to fix the sulphuretted hydrogen. It will be noted that in case there is sulphuretted hydrogen present, we get sulphate of copper as a resultant, which, as said above, is a useful and valuable disinfectant, so that if the reaction goes no further, there is apparently sufficient excuse and reason for the introduction of a little copper chloride into a general disinfectant.

Chloride of zinc, if we may trust our practical use, is one of the most efficient deodorants known. We have many examples where its value in obliterating bad odors has been very satisfactorily shown, and it will be observed that we use quite a large percentage of chloride of zinc in our disinfectant. Those who care to figure the matter out will note that the dilution given in the directions gives a little over 10 per cent. of chloride of zinc in the disinfectant ready for use. The experiments of the Committee on Disinfectants of the American Public Health Association show that chloride of zinc in this strength is a fairly efficient disinfectant, so that, so far as absolute disinfection goes, we cannot but feel that our standard disinfectant is efficient from at least two of its constituents—namely, the mercuric chloride and the chloride of zinc

The spirits of turpentine and the terebene are added not so much for the purpose of disinfection, but as a tell-tale. It may seem a little strange, but one of the difficulties which constantly occurs on all railroads is to get efficient service from the men, and the object of the terebene, the odor of which is very persistent, is to be able to know whether the men have used the disinfectant as they may say they have. Disinfectant containing the proper amount of terebene used in the closet of a car should leave the odor for at least 24 hours, and possibly still longer. In itself terebene is believed to be in a slight extent a disinfectant, but we do not rely much upon it in this light.

It is fair to say that there are other disinfecting materials well known which possibly might be fully as efficient as the ones which we use. We spent a good deal of study and time on the question when we were deciding on the constituents of our disinfectant, and did not see our way clear to do differently than we have done. We are quite well aware that chlorine and the hypochlorites are extremely valuable; also that carbolic acid itself is valuable; also that permanganate of potash with bichloride of mercury is extremely valuable. The merits of these various compounds were carefully discussed at the time when we established our disinfectant, and some were left out for one reason and some for another. Chlorine and the hypochlorites are not easily managed in places where people congregate. There is an exceedingly objectionable odor likewise to carbolic acid, which odor at times may mask the odor that an attempt is being made to kill. Our own disinfectant has only the odor of terebene, which is extremely pleasant, and we do not at all attempt to remove one bad odor by substituting another, which, if we are rightly informed, is a far too common method of disinfection. Our experience with permanganate and bichloride is not wide, and what little we do know is not against it but in favor of it. It had not come forward very prominently when we established our disinfectant. Moreover, its deodorant properties, so far as we know, are much less than our standard disinfectant. Upon the matter of deodorization we may, perhaps, safely say that many places occur on railroads where there is an objectionable odor, without said odor or its sources being strictly dangerous to health. This, as we understand the matter, is clearly the case in car closets. A disinfectant, therefore, which would not overcome this odor, while it might be thoroughly efficient against disease, would not be as satisfactory for general railroad use as a disinfectant which was likewise a good deodorant. The most serious objection to our disinfectant which we have yet found is that it slowly acts on metal pipes. The presence of the copper causes slight action on copper pipes, and lead, as is well known, is affected by bichloride of mercury. Our experience, however, for some six years now has shown that the action is so slow that we have not really received any serious detriment from this cause, and unless some new disinfectant comes forward which is equally as efficient as a deodorant and also as a disinfectant proper, which has no action on metal pipes, we should consider the matter quite carefully before we would change.

It will be observed that our disinfectant is put up in two ways—in bottles and in barrels—and that the two disinfectants differ from each other a little in composition. It should be stated that when the material is diluted for use there is no difference in the diluted material, the proportions of water added to the original material in the two cases being different. In order to distribute the disinfectant in bottles, they are put in boxes with crate partitions, 24 bottles in a box, with a cover screwed on. Each box is readily handled, and the material is shipped to the various stations where it is required for use, the boxes and bottles being returned for use again. The barrel shipments are made use of for those places which use large amounts of disinfectant. One barrel is equivalent in disinfecting power to 24 boxes of two dozen bottles each.

The specifications having been issued, the question of how to obtain the disinfectant at once arose. The Purchasing Department was asked to get bids for making disinfectant according to the specifications. It is a little interesting to note that the lowest bid per bottle for disinfectant without the boxes used for distribution from the storehouse to the various stations was 14 cents per bottle. This figure was so high that the question of making the disinfectant ourselves under the charge of the Laboratory was at once taken up; the result being that the disinfectant for the use of the whole road is now made at Altoona, under the charge of the Laboratory, and distributed to the various places where it is to be used. The cost, including the bottles, which makes it strictly comparative with the bid above mentioned, is 5 cents per bottle. The actual cost of the disinfectant in the bottle, provided the box and bottle used for distribution are returned, is only about 2½ cents per bottle. The cost of the disinfectant in barrels is somewhat less than this, since the labor of bottling is not required, and also the breakage and loss of bottles and the damages to the boxes in transit, which expense must of course be met, is considerably less.

The method of making the disinfectant at Altoona is very simple. We do not expect to give enough information to enable any one to set up in business for themselves, as there are some little details of manipulation which we shall probably fail to mention; but in general we may say that we start with muriatic acid, and add white zinc to this in certain proportions, enough to about two-thirds or three-quarters saturate the acid. We then add metallic zinc, in the form of old battery zincs, which are received from the service at a very cheap rate, and allow the acid to act until it is saturated. This operation is usually conducted in half barrels. An ordinary good oak half-barrel will last to make 100 gross or more of bottles, the action of the material on the wood being very light. The material is then strained, and the proper amount of a mixture of sulphate of copper with common salt, which results in the formation of chloride of copper, added, the proper

amount of bichloride of mercury added, and the material diluted by the addition of water to the proper strength and thoroughly mixed. It will be understood that the action of the acid on the zinc results in the formation of considerable heat, and the evaporation of some of the water mixed with the acid, so that when the "boiling," as it is technically called, is done, the solution of chloride of zinc is too strong and is hot, hence the addition of the water to dilute. After all the ingredients are in, the material is allowed to stand over night, and is then drawn off into bottles. A half barrel will readily hold a batch of two gross of eight-ounce bottles. The terebene and turpentine are added as each bottle is filled. For the barrel use the material is treated in exactly the same way, except that after it has set over night and has settled perfectly clear, it is drawn off into a barrel and the proper amount of water added to fill the barrel. The reason why the disinfectant in barrels is not quite as concentrated as in the bottles is because we find the concentrated material shrinks the staves a little, and is apt to cause leakage. As stated above, the diluted material, when it is ready for use, is the same whether the disinfectant is obtained in bottles or barrels.

The results from the use of the P. R. R Standard Disinfectant have been exceedingly satisfactory. Every new disinfectant that is offered, as stated above, is compared either in efficiency or cost with the P. R. R. Standard; and thus far we have not found anything that was as efficient for as little money as our standard. Also in service the results are as satisfactory as we can wish. The disinfectant is so efficient that the men observe a change in the atmosphere at once where the disinfectant has been used. Also the price is low enough, so that the material can be used freely without any serious increase in expenditures. It may seem a little singular, but in reality it is difficult to get the men to use as much as we could wish. In other words, the closets in cars and the outhouses are not kept as clean as they should be, owing to lack of attention. The management would be pleased if the total use on the road, instead of being, perhaps, 250 gross of bottles or its equivalent per year, was 500 gross.

In order to stimulate attention to the matter of disinfection and general cleanliness, the following circular has been issued. The copy given below is the second or third revision. These circulars have been printed and posted on cards in the shops and other places frequented by the employés, and also a large number of them were printed and distributed among the men. The circular is as follows:

PENNSYLVANIA RAILROAD COMPANY.

CIRCULAR IN REGARD TO DISINFECTION.

The efficiency of the service depending largely on the health of the employés, the attention of all is called to the following points, in regard to disinfection, and general preventive measures against disease.

CLEANLINESS.

One of the most important means of preventing disease is cleanliness, not only of the body, but also of surroundings. No disinfectant or medicine can take its place. The following rules must be observed:

I. All shops, stations, and adjacent grounds, as well as the tracks between stations, must be kept scrupulously clean. DECAYING ANIMAL OR VEGETABLE MATTER, AND RUBBISH OF EVERY KIND MUST BE BURNED.

II. The floors and seats of privies everywhere must be scrubbed with soap and water not less than once in two weeks, and the vaults emptied whenever the material accumulates to within three feet of the surface of the ground. In no case should a privy vault be less than five feet deep.

III. Drains and sewers must be flushed with fresh water as often as once a week, if the water supply will admit.

IV. Passenger cars must be thoroughly ventilated, and the plush beaten frequently. The paint and glass must be washed at least once in two weeks.

V. THE CLOSETS OF PASSENGER CARS, ESPECIALLY THE FLOOR, URINAL, AND HOPPER, MUST BE WASHED AT LEAST ONCE A WEEK WITH "P. R. R. DISINFECTANT," ACCORDING TO THE DIRECTIONS GIVEN.

VI. Freight cars at stations must be cleaned before leaving the station, and if the refuse from these cars cannot be satisfactorily disposed of otherwise, it must be burned.

WATER SUPPLY.

Too great care cannot be exercised in keeping the water supply used for drinking and household purposes free from contamination, impure water being one of the most effective means of spreading disease. The following points should be observed:

I. Privies and stables, and outlets of drains and sewers, are frequently so located that the drainage therefrom finds its way readily into the water supply. This should never be.

II. As a rule it is better to take water supply from rapidly running streams than from any other source, and always some distance above the nearest contamination. Springs, where the high land surrounding them is free from impure drainage, are excellent sources of water supply. Wells, especially those near dwellings, should be avoided.

III. IN ALL CASES WHERE A WATER SUSPECTED OF CONTAMINATION MUST BE USED FOR DRINKING, OR AS A CONSTITUENT OF FOOD, SUCH WATER SHOULD BE BOILED AND THEN ALLOWED TO COOL AND SETTLE BEFORE IT IS USED. IT IS BETTER NOT TO ADD ICE TO THE BOILED WATER, AS ICE ITSELF IS FREQUENTLY CONTAMINATED. Boiled water may be readily cooled by having it in a metal or earthen vessel, and after wrapping a wet towel around the vessel, placing it in a current of air, or by placing ice in contact with the vessel outside.

IV. Garbage and rubbish of all kinds near the water supply must be burned or removed.

DISINFECTION.

The best disinfectant known is simply fire. Burn up everything in the shape of filth, and it will never cause further difficulty. In some cases, however, this is impossible, and in such cases disinfectants and antiseptics are properly used, especially (1) to remove offensive odors, (2) to render decaying organic matter which cannot be burned less dangerous, and (3) most important, to destroy disease germs. It is believed that the "P. R. R. Disinfectant" will accomplish each of these results. If it is properly used after filth and rubbish of all kinds have been burned or disposed of as directed above, offensive odors everywhere will be reduced to a minimum, and the danger of disease will be very greatly diminished.

I. THIS DISINFECTANT MUST BE USED FREELY, and all persons in charge of shops, stations, cars, or any portion of the Company property, will be held strictly responsible that the property is as clean and free from odor as possible. P. R. R. Disinfectant is made under the supervision of the Laboratory at Altoona, and may be obtained in boxes holding two dozen bottles by making requisition on Altoona Shops. Directions for use accompany each bottle. For use where slight stain is objectionable, a special form of P. R. R. Disinfectant is made which does not stain.

II. For disinfecting clothing, bed linen, or other articles which have become contaminated, and which it is not desirable to burn, the best disinfectant is simply to boil in water for at least half an hour.

III. Sulphate of Copper, or Blue Vitriol, also known as "Blue Stone," is a very valuable disinfectant. In damp places, in privy vaults, and in cesspools, it may be used freely in the dry form, being simply coarsely powdered and scattered around. In other places it should be dissolved in water before use, not less than one-half pound to the gallon of water.

IV. Sulphate of iron, or Copperas, is also valuable, especially as an antiseptic. It is much cheaper than Sulphate of Copper, and should be applied in the same way, and for the same purposes, except that two or three times as much should be used.

V. Ice is very valuable in preventing decomposition, and in this sense is a good antiseptic. It may be used with great advantage on passenger cars, and in the urinals of water-closets at stations. In all cases where the supply will admit, a lump of ice must be kept in the urinal of every passenger car while the car is in service.

INFECTIOUS DISEASES.

If at any time a case of infectious disease is found at a station, in a passenger car, or elsewhere on the Company's property, a physician should be immediately sent for. The car should be removed from the train as soon as practicable, the doors locked, and it should not again be used until it has been fumigated.

The foregoing has been approved by the Pennsylvania State Board of Health, and all employés are expected to heartily cooperate in the above measures for preventing disease, and they are earnestly recommended to apply them also at their own homes.

CHAS. E. PUGH,
General Manager.

Office of General Manager, Philadelphia, May 25, 1889.

The various points mentioned in the above circular will,

perhaps, readily explain themselves. It is the desire and hope of the management to constantly do something to educate its employés to a higher state of efficiency in regard to preventive measures against disease, the above circular being one of the various means employed. As knowledge increases on the subject treated, new editions or revisions of the circular will undoubtedly be issued.

We hope in the next article to take up the question of steel for springs.

(TO BE CONTINUED.)

CORRUGATED FIRE-BOXES FOR LOCOMOTIVE BOILERS.

DURING the past year, as has been heretofore noted in our columns, considerable attention has been given in Germany to the use of corrugated fire-boxes for locomotive boilers. The advantages claimed by their advocates have been simplicity and cheapness; greater strength, owing to the absence of flat surfaces, the outside shell of the boiler being a plain cylinder; the dispensing with a large number of stay-bolts required with the ordinary form of boiler; and a decrease in weight, which can be improved by increasing the size and capacity of the boiler.

The accompanying sketches, which are taken from *Glaser's Annalen*, show plans for boilers with corrugated fire-boxes which have been recently prepared by Chief Inspector Bobertag, of the Prussian State Railroads. Two of them are to replace old boilers of the ordinary type, and the third is for a proposed new class of engines for fast passenger service.

Fig. 1.

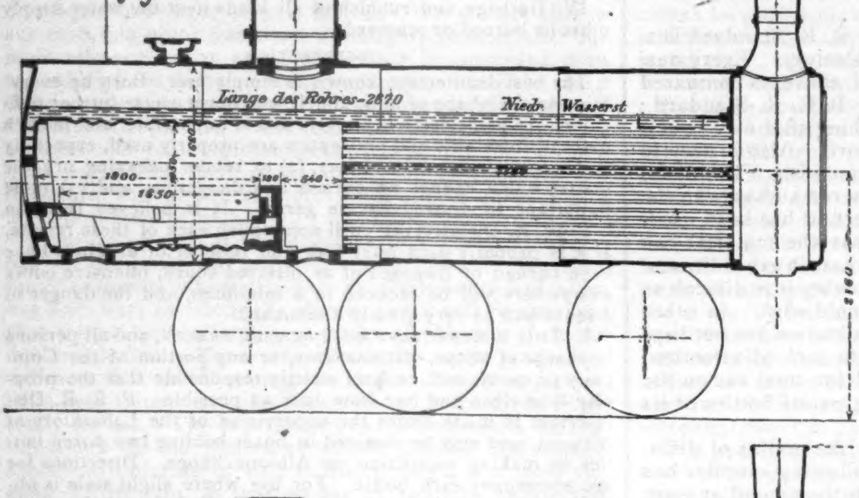
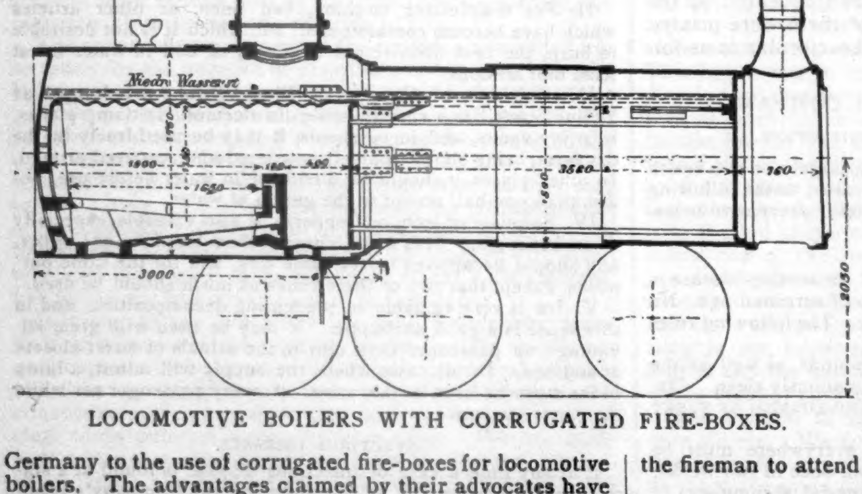


Fig. 2.



LOCOMOTIVE BOILERS WITH CORRUGATED FIRE-BOXES.

The first boiler, shown in section in fig. 1, is for a six-wheel freight engine of the type in ordinary use on the Prussian lines. It is a plain cylinder with the corrugated fire-box inserted, the method of bracing and staying being indicated in the sketch. This form of boiler, it is claimed, is the strongest and cheapest that can be made for a locomotive; and Herr Bobertag says that the cost will be 33⅓ per cent. less than that of a boiler of the same steam-making capacity of the ordinary type.

Fig. 2 shows a boiler of very similar construction. It is intended for the same class of locomotives, and differs from that shown in fig. 1 chiefly in having the rear end of greater diameter than the rest of the barrel. This boiler is also a strong and simple type; the difference in cost would be chiefly in the expense of flanging the plates to make the joint between the barrel and the enlarged rear end, or outside fire-box. This form of boiler, however, might be more convenient in some instances, especially where the driving wheels are of considerable size.

Fig. 3 shows a boiler designed for a new class of locomotives for fast passenger work. In this case it will be noticed that the engine is of the Forney type, with four coupled wheels under the boiler and a four-wheeled truck under the rear end, the frames being prolonged far enough to carry a tank and coal-box. The boiler is of the same type as that shown in fig. 2, the rear end being larger in diameter than the main part of the barrel.

Another boiler designed is the same as fig 3, except that there is no water-space at the rear end. The fire-box is riveted to the plate forming the boiler-head, which is flanged to receive it, and the plate closing the fire-box is protected by fire-brick. It is claimed by Herr Bobertag that this arrangement of the rear end of the boiler presents advantages over the water-pace, and that little or no heat is lost by it, while it is at once stronger and cheaper.

The use of the corrugated fire-box and the boiler of entirely cylindrical form permits the driving-wheels to be placed in the best position without reference to the fire-box. It is quite a usual practice to put one of the driving-axles under the fire-box, but the inconveniences of such an arrangement are well known. The chief objection to the corrugated fire-box seems to be that it makes a long and narrow grate necessary, and in very large locomotives the length would be so great as to make it very hard work for the fireman to attend properly to his fire.

THE VYRNWY WATER WORKS.

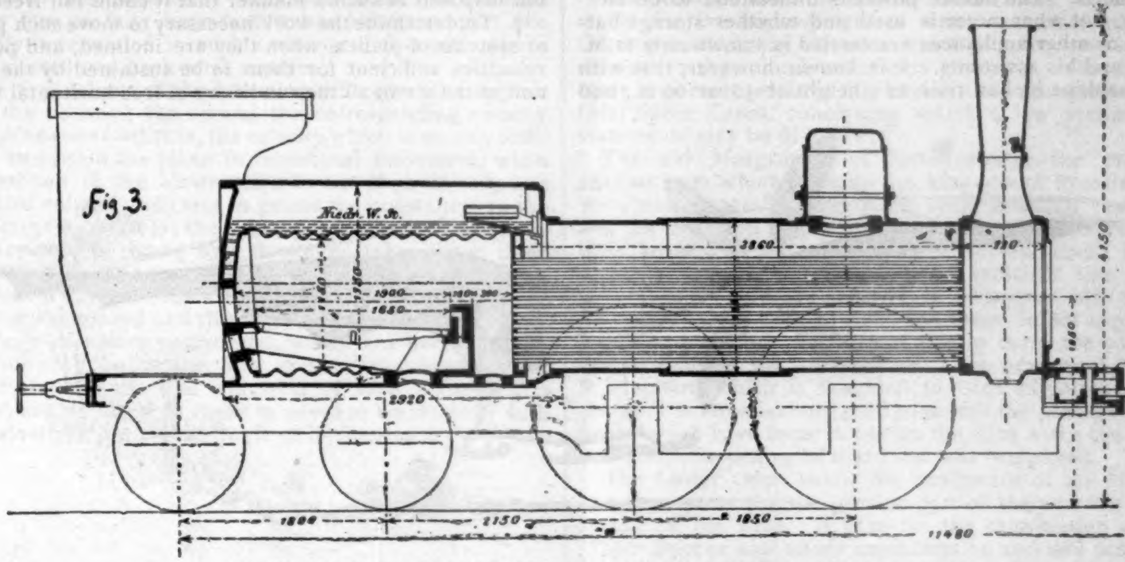
(From *Industries*.)

As the works for bringing the Liverpool water supply from the Vyrnwy Valley to the reservoir at Prescot are now completed, with the exception of the short connecting link in the pipe line under the Mersey, a short *résumé* of the work may be of interest. The Vyrnwy Valley lies about six miles to the southeast of Bala Lake, at an elevation of 780 ft. above the level of the sea, into which flows

the River Vyrnwy, the waters of which are now impounded by the masonry dam, forming a lake 4¾ miles long, with an acreage of 1,121 acres when full, and a maximum depth of 84 ft. Compensation water to the river below has to be provided for at the rate of 10,000,000 galls. per day, and 40,000,000 galls. upon four days in each of the months between March and October inclusive. The size of the masonry dam is as follows: Width of base, outside toes, 117.75 ft.; height from base to top of overflow, 128 ft.; maximum depth from top of dam to bottom of lake, 84 ft.; area of typical section, 8,972 sq. ft.; weight per lineal foot, 645 tons; its specific gravity, 2.57; maximum pressure on inner toe, 8.7 tons per sq. ft.; on outer toe, 2.26 tons per sq. ft. The total length of dam is 1,173 ft. The aqueduct commences at the straining tower in the middle of the lake, a culvert 2,295 ft. long passing under the bed of the lake; it then enters the Hirnant tunnel, 2.375 miles long. The pipes, 42½ in. in diameter, then pass underground for about 7 miles, except when crossing a stream, and then discharge the water into the Parc Uchaf balancing reservoir. They then pass another 6 miles underground, and enter the Cynyerion tunnel, 0.875 mile in length, and passing the narrow Morda Valley, enter the Llanforda tunnel, a mile in length, and discharge into the Oswestry reservoir, having a capacity of 46,112,000 galls. The water passes through the filter beds to the clear water reservoir, whence it flows for 17 miles underground to Malpas—except when crossing the Wych Brook, with nine arches—into the balancing reservoir. The pipes then proceed for another 11 miles underground to the Cotebrook balancing reservoir, and thence to Norton, 11 miles away. The hill being below the hydraulic gradient a tower has been built in place of a balancing reservoir. In this last length the pipes pass under the River Weaver and two main railroad lines. The next length, from Norton Tower to Prescot, is 9.25 miles long, and has to pass under the Manchester Ship Canal and the River Mersey.

This crossing under the Mersey has been a source of trouble both to the engineer and the contractor, on account of the treacherous nature of the sub-strata, and has been the cause of litigation between the contractor and the Corporation, the case being now heard before Sir John Coode as arbitrator. On account of the great delay in the construction of the tunnel which was to contain the mains, it was decided to put a temporary pipe line across the bed of the river, the necessary leave having been obtained from the Board of Trade. The pipe consists of fifty lengths of 12-in. steel tubes, making a total length of 800 ft. The joints of the pipes are flexible, and are constructed as shown in fig. 1. In addition to the flexible joints, Mr. Deacon, the Corporation engineer, devised some special valves, which were attached to the under side of the pipes, with the intention that, as the pipes were being laid across the bed of the river, the force of the water in the mains would force open the valves and scour a bed for the pipes, the valves then to close automatically. The pipes were laid across the river about six weeks ago in a very clever manner. The pipe line of 800 ft. was laid zigzag in a trench, a block of wood being under each joint, and riding on the ways; along each side of the pipes was a wire rope secured to the extreme end of the pipes, and passing over to the Cheshire side of the river, where they were attached to a steam winch. Eight boats were moored at intervals across the river to guide the pipes as they were being drawn across; a number of horses were also attached, and, with the united forces of the steam winch and the horses, the pipes were successfully pulled across the river in 27½ minutes. Unfortunately, the valves under the pipes have become deranged with the dragging across the banks, and will not close; some of the flexible joints are leaking, and, with the pressure nearly full on, about 75 per cent. of the water which should be filling the Prescot reservoir is flowing into the River Mersey. It is stated, however, that the leaks were expected, and will close up in time, and meanwhile divers are at work upon them to hasten the desired result.

Fig 3.



LOCOMOTIVE BOILER WITH CORRUGATED FIRE-BOX.

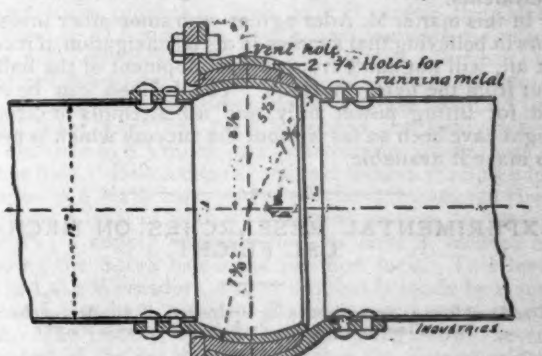


Fig. 1.

A NEW FLYING MACHINE.

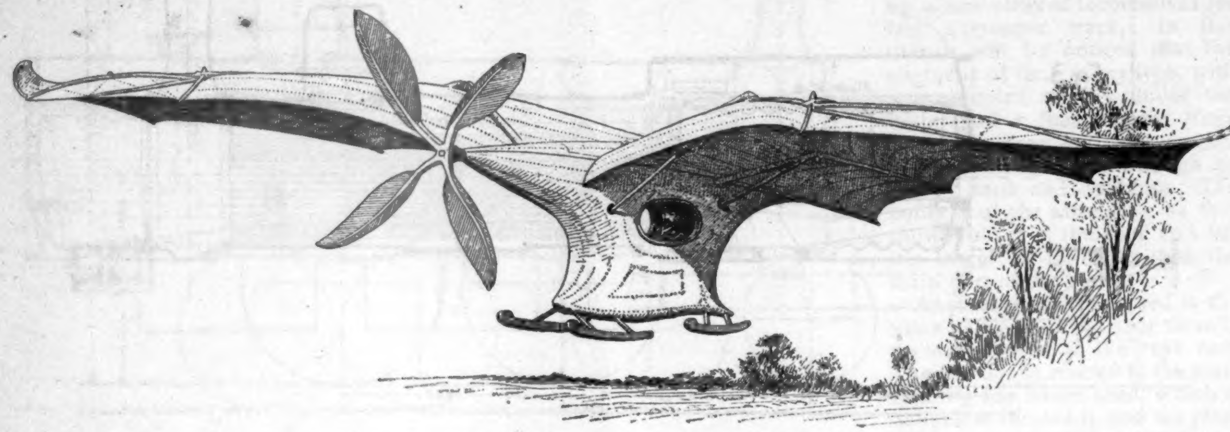
THE accompanying sketch, which is taken from *l'Illustration*, of Paris, shows a flying machine which has been built recently by M. Ader, the famous French electrician and inventor. Some time ago M. Ader became convinced that the true secret of successful aerial navigation lay in imitating the flight of the larger birds, such as the vulture and the eagle. With this in view he took all possible op-

portunities of studying the motions of such birds, even going so far as to spend several weeks at Constantine and Sidi-M' Sid, in Algeria, where large vultures abound.

The result of his observations is embodied in the machine which is shown in the sketch. The wings are of silk stretched over a light framework, are as nearly as possible of the same form as those of a large vulture, and have an extreme spread of 54 ft. The car or carriage, which takes the place of the body of the bird, carries the motor and the man who is to direct the movements of the machine. It has in front a large screw which is relied on to direct the machine and propel it through the air. The wings have a flapping motion, to be used when rising; this and the revolution of the screw are produced by the motor carried in the car.

It is impossible to give a better description, as M. Ader will not make public the details until his experiments are concluded. The motive power is understood to be electricity, but what motor is used and whether storage batteries or other appliances are carried is known only to M. Ader and his assistants. It is known, however, that with this machine he has risen to a height of 50 or 60 ft., and has made flights of 1,000 and 1,200 ft. in horizontal distance so successfully as to encourage him to continue experiments.

In this matter M. Ader agrees with some other investigators in believing that success in aerial navigation, if it comes at all, will not come from the development of the balloon, but from the flying machine. The balloon can be relied on for lifting power only, and all attempts to direct its flight have been so far without the success which is needed to make it available.



THE ADER FLYING MACHINE.

EXPERIMENTAL RESEARCHES ON MECHANICAL FLIGHT.

(Translated from a communication by Professor S. P. Langley, of the Smithsonian Institution, to the Paris Académie des Sciences.)

I HAVE been carrying out some researches intimately connected with the subject of mechanical flight, the results of which appear to me to be worthy of attention. They will be published shortly in detail in a memoir. Meanwhile I wish to state the principal conclusions reached.

In this memoir I do not pretend to develop an art of mechanical flight; but I demonstrate that, with motors having the same weights as those actually constructed, we possess at present the necessary force for sustaining, with very rapid motion, heavy bodies in the air; for example, inclined planes more than a thousand times denser than the medium in which they move.

Further, from the point of view of these experiments, and also of the theory underlying them, it appears to be demonstrated that if, in an aërial movement, we have a plane of determined dimensions and weight, inclined at such angles and moving with such velocities that it is always exactly sustained in horizontal flight, the more the velocity is augmented the greater is the force necessary to diminish the sustaining power. It follows that there will be increasing economy of force for each augmentation of velocity up to a certain limit, which the experiments have not yet determined. This assertion, which I make here with the brevity necessary in this *résumé*, calls for a more ample demonstration, and receives it in the memoir that I have mentioned.

The experiments which I have made during the last four years have been executed with an apparatus having revolving arms, about 20 meters in diameter, put in movement by a 10-H.P. steam-engine. They are chiefly as follows:

1. To compare the movements of planes or systems of planes, the weights, surface, form, and variable arrangements, the whole being always in a horizontal position, but disposed in such a manner that it could fall freely.

2. To determine the work necessary to move such planes or systems of planes, when they are inclined, and possess velocities sufficient for them to be sustained by the reaction of the air in all the conditions of free horizontal flight.

3. To examine the motions of aërostats provided with their own motors, and various other analogous questions that I shall not mention here.

As a specific example of the first category of experiments which have been carried out, let us take a horizontal plane, loaded (by its own weight) with 464 grams, having a length of 0.914 meter, a width of 0.102 meter, a thickness of 2 mm., and a density about 1900 times greater than that of the surrounding air, acted on in the direction of its length by a horizontal force, but able to fall freely.

The first line below gives the horizontal velocities in meters per second; the second the time that the body took to fall in air from a constant height of 1.22 meters, the time of fall in a vacuum being 0 50 second.

Horizontal velocities	0m., 5m., 10m., 15m., 20m.
Time taken to fall from a constant height of 1.22 meters	0.53s., 0.61s., 0.75s., 1.05s., 2.00s.

When the experiment is made under the best conditions it is striking, because, the plane having no inclination, there is no vertical component of apparent pressure to prolong the time of fall; and yet, although the specific gravity is in this more than 1,900 times that of the air, and although the body is quite free to fall, it descends very slowly, as if its weight were diminished a great number of times. What is more, the increase in the time of fall is even greater than the acceleration of the lateral movement.

The same plane, under the same conditions, except that it was moved in the direction of its length, gave analogous but much more marked results; and some observations of the same kind have been made in numerous experiments with other planes, and under more varied conditions.

From that which precedes, the general conclusion may be deduced that the time of fall of a given body in air,

whatever may be its weight, may be indefinitely prolonged by lateral motion, and this result indicates the account that ought to be taken of the inertia of air, in aërial locomotion, a property which, if it has not been neglected in this case, has certainly not received up to the present the attention that is due to it. By this (and also in consequence of that which follows) we have established the necessity of examining more attentively the practical possibility of an art very admissible in theory—that of causing heavy and conveniently disposed bodies to slide or, if I may say so, to travel in air.

In order to indicate by another specific example the nature of the data obtained in the second category of my experiments, I will cite the results found with the same plane, but carrying a weight of 500 grams—that is, 5,380 grams per square meter, inclined at different angles, and moving in the direction of its length. It is entirely free to rise under the pressure of the air, as in the first example it was free to fall; but when it has left its support, the velocity is regulated in such a manner that it will always be subjected to a horizontal motion.

The first column of the following table gives the angle a with the horizon; the second the corresponding velocity V of *planement*—that is, the velocity which is exactly sufficient to sustain the plane in horizontal movement, when the reaction of the air causes it to rise from its support; the third column indicates in grams the resistances to the movement forward for the corresponding velocities—a resistance that is shown by a dynamometer. These three columns only contain the data of the same experiment. The fourth column shows the product of the values indicated in the second and third—that is to say, the work T, in kilogram-meters per second, which has overcome the resistance. Finally, the fifth column P designates the weight in kilograms of a system of such planes that a 1-H.P. engine ought to cause to advance horizontally with the velocity V and at the angle of inclination a.

	V	R	$T=\frac{VR}{1000}$	$P=\frac{500 \times 4554}{T \times 60 \times 1000}$
45	11.2	500	5.6	6.8
30	10.6	275	2.9	13.0
15	11.2	128	1.4	26.5
10	12.4	88	1.1	34.8
5	15.2	45	0.7	55.5
2	20.0	20	0.4	95.0

As to the values given in the last column, it is necessary to add that my experiments demonstrate that, in rapid flight, one may suppose such planes to have very small interstices, without diminishing sensibly the power of support of any of them.

It is also necessary to remark that the considerable weights given here to the planes have only the object of facilitating the quantitative experiments. I have found that surfaces approximately plane, and weighing ten times less, are sufficiently strong to be employed in flight, such as has been actually obtained, so that in the last case more than 85 kilograms are disposable for motors and other accessories. As a matter of fact, complete motors weighing less than 5 kilograms per H.P. have recently been constructed.

Although I have made use of planes for my quantitative experiments, I do not regard this form of surface as that which gives the best results. I think, therefore, that the weights I have given in the last column may be considered as less than those that could be transported with the corresponding velocities, if in free flight one is able to guide the movement in such a manner as to assure horizontal locomotion—an essential condition to the economical employment of the power at our disposal.

The execution of these conditions, as of those that impose the practical necessity of ascending and descending with safety, belongs more to the art of which I have spoken than to my subject.

The points that I have endeavored to demonstrate in the memoir in question are:

1. That the force requisite to sustain inclined planes in horizontal aërial locomotion diminishes, instead of increasing, when the velocity is augmented; and that up to very high velocities—a proposition the complete experimental demonstration of which will be given in my memoir; but I hope that its apparent improbability will be diminished by the examination of the preceding examples.

2. That the work necessary to sustain in high velocity the weights of an apparatus composed of planes and a motor, may be produced by motors so light as those that have actually been constructed, provided that care is taken to conveniently direct the apparatus in free flight; with other conclusions of an analogous character.

I hope soon to have the honor of submitting a more complete account of the experiments to the Academy.

THE ODER-SPREE CANAL.

(Condensed from *Annales des Ponts et Chaussées*.)

References have heretofore been made to various works for the improvement of water communication in Germany, and to the attention which is being paid in that country to the inland waterways generally. One of the more important works of this kind is now in progress in the Oder-Spree Canal, concerning which a few preliminary statements may be of interest.

The old Margravate of Brandenburg, the original nucleus from which grew up the kingdom of Prussia, is a wide and generally level plain, lying between the Elbe and the Oder and intersected by the Havel, the Spree and their tributaries; it also contains several small lakes. These rivers are not generally of sufficient size to be navigable. There are already in existence old canals uniting the Oder and the Elbe, but these do not approach Berlin and are not of sufficient size to carry the boats in use on either of the great rivers. The new canal is part of a system which is intended to reach all points of importance in Brandenburg, and to permit the passage of the boats which have been in use on the Elbe since the regulating and deepening of that river was completed.

The Lower Oder, below the confluence of the Neisse, can now carry for the greater part of the year the boats in use on the Elbe. A plan for the canalization of the Upper Oder is now under consideration and will probably be carried out. The object of the Oder-Spree Canal is to furnish a line connecting the Oder and the Elbe, which will also reach the city of Berlin.

The new canal leaves the Oder at Fürstemburg, passes under the Berlin-Breslau Railroad, and then by a series of three locks reaches a level 43.5 ft. above the Oder. This level is 22.6 miles in length, and includes 7.1 miles of the old Frederick-William Canal, which has been enlarged and deepened. This level extends to Lake Kersdorf, from which the channel descends by a single lock into the Spree. That river has been deepened and straightened for a distance of 9.3 miles, to Fürstenwalde, where there is another lock. Below this the channel follows the Spree for 3.7 miles to a sixth lock, where the canal leaves the river and enters a level of entirely new construction, 16.3 miles in length; a supply of water for this level is secured by damming the Spree below the junction lock. This level ends in Lake Wernsdorf, and a descent is made by a seventh and last lock into the Dahme, a tributary of the Spree. The Dahme, with the necessary regulation, serves as the bed of the canal until it reaches the Spree again at Cöpenick, from which point that river has already been made navigable to Berlin.

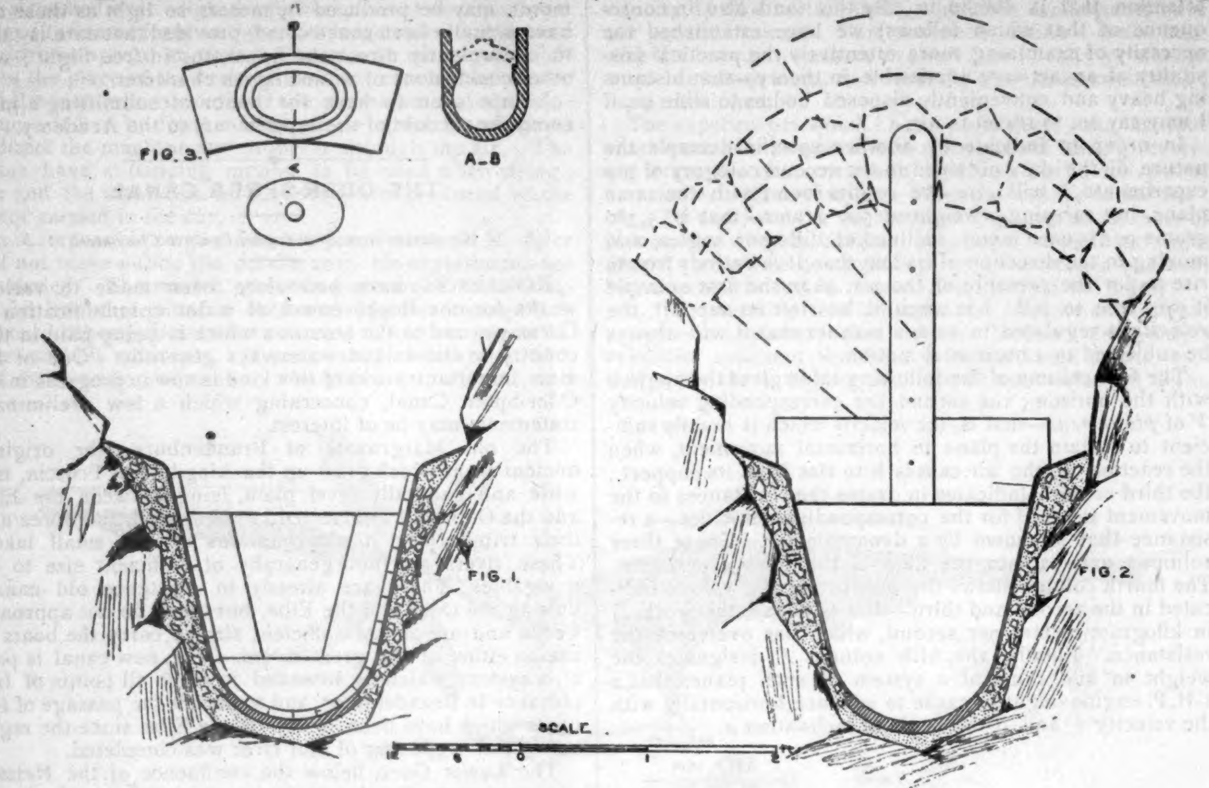
The total fall from the summit level to Cöpenick is 29.4 ft., which is made in four locks. The total number of locks is seven, as already noted; two of these, at Fürstemburg and Wernsdorff, have a fall of 16.2 ft. each, the elevation of the others being less.

The total length of the canal is 54.7 miles, which includes 34.7 miles of entirely new construction, 7.1 miles of the old Frederick-William Canal enlarged, and 12.9 miles of regulated river channels.

The canal is made throughout 45.9 ft. wide at the bottom and 76 ft. at water level, for a depth of 6.56 ft., the great inclination of the banks being adopted on account of the nature of the soil, which is generally a very fine sand. For a considerable part of its length the banks are protected from wash by rip-rapping. While the dimen-

sions given above are the minimum, they are exceeded at several points as required by local circumstances.

The locks have been made to admit of the passage of the average sized boats in use on the Elbe, which are 172.5 ft. long, 23 ft. wide, and draw 5.7 ft. of water when



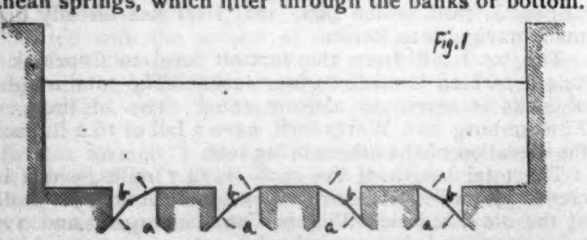
CONCRETE SEWER AT MOUNT VERNON, N. Y.

loaded. The locks are 180 ft. long, 28.2 ft. wide at the gates and 31.5 ft. at the center, and carry 8.2 ft. depth of water. It is proposed, however, to enlarge the canal hereafter to take in the largest class of boats in use on the Elbe. In that case a second lock, 220 ft. long, will be built alongside each of the existing ones, and the minimum section of the canal will be increased to 53.1 ft. width at bottom and 89.2 ft. at water-level, with a depth of water of 8.2 ft.

The bridges over the canal are all built so as to give two clear openings of 32.8 ft. each, and the minimum height is 11.5 ft. above the water-level.

The masonry works include the seven locks; two double-track railroad bridges; a road bridge in the marshes of the Oder; a bridge at Fürstemburg carrying a highway road and a steam tramway; 16 highway bridges, each 14.8 ft. in width; a bridge and automatic guard-gate intended to close the canal in case of a break in the banks; two other guard-gates and a number of culverts and smaller works.

A large part of the water supply will come from subterranean springs, which filter through the banks or bottom.



In addition to this the summit level can be fed from the Schlaube, which carries a considerable volume of water. Should this prove insufficient at any time, it will be necessary to pump up water from the Spree at Neuhaus.

The total amount of excavation required is about 6,530,000 cub. yds. Part of this is done by dredges, but the larger part is excavated dry. Wherever possible steam-shovels are used, and in many places the earth excavated is deposited alongside of the canal, thus saving transportation.

The masonry is generally of brick, set in cement. The locks are founded on béton worked in on a sub-floor of plank set on piles. The gates at the upper ends of all the locks are of iron and are worked by capstans; these will hereafter be replaced by hydraulic apparatus. The lower gates are of wood, and move around horizontal axes. In filling the lock water is introduced from below, as shown in fig. 1, by channels *a a a a* made in the masonry, and closed by valves *b b b b* set in the openings and balanced so that they can be easily opened. The locks are emptied by lateral channels, also made in the masonry and closed by valves.

At latest accounts the canal was very nearly completed. The expectation was that it would be opened by the close of 1890, but some delays have occurred. A large part of the canal is in use, however, and the whole will soon be opened.

BUILDING A CONCRETE SEWER.

(Paper by Mr. William Worthen, before the American Society of Civil Engineers.)

IN laying out the main outlet sewer at Mt. Vernon, N. Y., it was found that a large portion of the line must be excavated through rock, and I decided that for economical reasons the sewer should consist of a concrete channel, constructed *in situ*, with an arch covering in stone. In this way all the rock saved from the trench was valuable for the macadamizing of streets, no earth was necessary for filling over the arch, which would have been needed if cement or vitrified sewer pipe had been laid, and this earth involved long haul. In addition, such a cross-section could be secured that a man could readily pass through the sewer, a convenience in cleaning, and a saving in the number of manholes. It was not supposed that at Mt. Vernon the sewer would be used as a subway for electric wires, gas or water pipes, but it could be readily arranged for such purposes.

Figs. 1 and 2 show sections of the sewer and the general form of construction; only the minimum of rock excava-

tion was required, sufficient in all cases to give a few inches in thickness of concrete. The invert is a section of vitrified pipe, such as is sold for such purposes; this is bedded in cement mortar on the rock or on concrete to a true line and grade; on this is placed the invert center, fig. 1, and concrete of Rosendale cement-mixed 1 cement, 2 sand, and 4 of broken rock not larger than 2 in., is rammed around its sides. After the concrete has set, the invert center is removed and the face of the cement is struck with a thin coat, say ¼ in. thick, of Portland cement well troweled on, a plumb ⊥, fig. 2, of which the base fits the opening of the channel, is placed within it so as to be central and vertical. In this plumb are a number of holes, which are centers for describing the arch, and the centers used are those best suited to the rock excavation. In this case the radius of the arch was invariably 2 ft., and this radius, either by a string or rod, was applied at different centers, till one was found best adapted to the rock cut.

In general the arches were laid horizontal and the same center in the plumb used for a convenient length or section; after that another center might be taken with a vertical offset, but if more convenient, the arches might be laid on an incline, so that in some places the sewer would be 6 ft. to 7 ft. high. The practice was to arrange for the skewbacks first and then set the usual centers of about 3 ft. wide and complete the arch from stone from 10 in. thick and upward, taken from the cut and laid in cement. The upper surface of the arch was kept as high as the rock cut and the proper depth below the grade of the street would admit.

This construction applied only to the main outlet sewer, in which there was no spur for house connections; all the other sewers were of vitrified pipe of various diameters from 8 to 18 in., the minimum being 8 in. All the house connections were 6 in. in diameter. By the provisions of the contract there was to be a capped ⊥ pipe next to the bend from the spur. The idea was to obtain ready access for the removal of obstacles in either the main sewer or its branches. To simplify this, the bend, fig. 3, was adopted, which was the first connection with the spur on the main line. The oblong hole gives a ready and short reach to both the main line and to the house connections. After the cover is put on with earth packing, the trench is filled in, and access can be got only by digging down. The usual depth of mains is 9 ft. to invert, and the distances between spurs, 25 ft. on each side.

In manholes where the lateral sewer came in on a level considerably above that of the main sewer, I put a ⊢ on the line of the lateral and just inside of the wall of the manhole with the upper end open, so that the flow of the lateral was readily seen, and the other end was extended down with an elbow at the bottom to the level of the main sewer.

CONTRACTS FOR NEW GUNS.

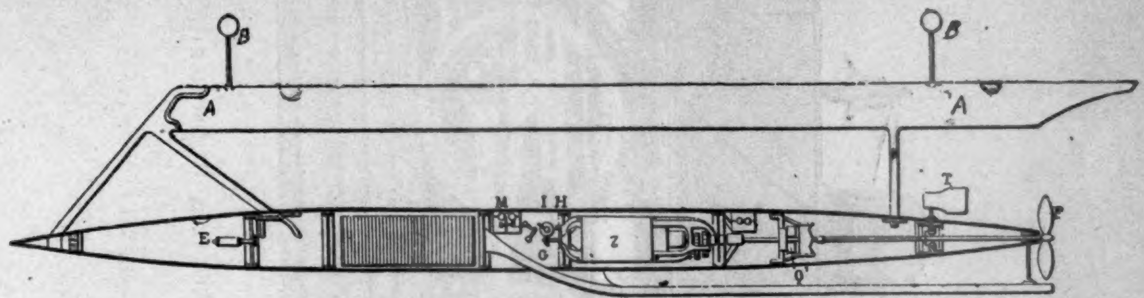
THE Acting Secretary of War on August 10 approved the recommendation of the Board of Ordnance and Fortification that the contract for 100 high-power, breech-loading, rifled steel guns be given to the Bethlehem Iron Company, Bethlehem, Pa. The award is made under Schedule E, the lowest of five bids submitted by that company; the difference in prices was considerable, and the difference in time also.

Under this bid the 100 new guns will be furnished by the Bethlehem Company as follows:

	Time.	Price.	
8-in. Guns:			
Type gun............	730 days.	$41,416.50	
24 service guns... ...	2,433 "	413,917.20	
			$455,333.70
10-in. Guns:			
Type gun............	882 "	$73,755.58	
49 service guns... ...	3,407 "	1,751,631.42	
			1,825,387.00
12-in. Guns:			
Type gun............	1,024 "	$106,568.72	
24 service guns.......	3,194 "	1,307,357.28	
			1,413,926.00
Total amount of contract.....................			$3,694,646.70

The delivery of the service guns is to be made at regular intervals after that of the type gun in each case, the time given in the table being that specified for the completion of the last gun. The price per service gun is: 8-in., $17,246.55 each; 10-in., $35,747.58 each; 12-in., $54,473.22 each.

The Bethlehem Company has now a very fine plant for making the heavy steel forgings required for these guns, and will doubtless be able to furnish them in excellent shape.



THE SIMS-EDISON TORPEDO.

THE UNITED STATES NAVY.

THE 2,000-ton cruiser now under construction at the Union Iron Works, Baltimore, will be named *North Point*. This ship comes under the same class as the *Concord*, vessels in which are required to receive the names of battles, and the name just given is intended to commemorate the fight at North Point, near Baltimore, in the War of 1812.

The practice-ship is not yet named, but it has been proposed to call her *George Bancroft*, in memory of the eminent historian, who was also the Secretary of the Navy under whose charge the Naval School at Annapolis was established.

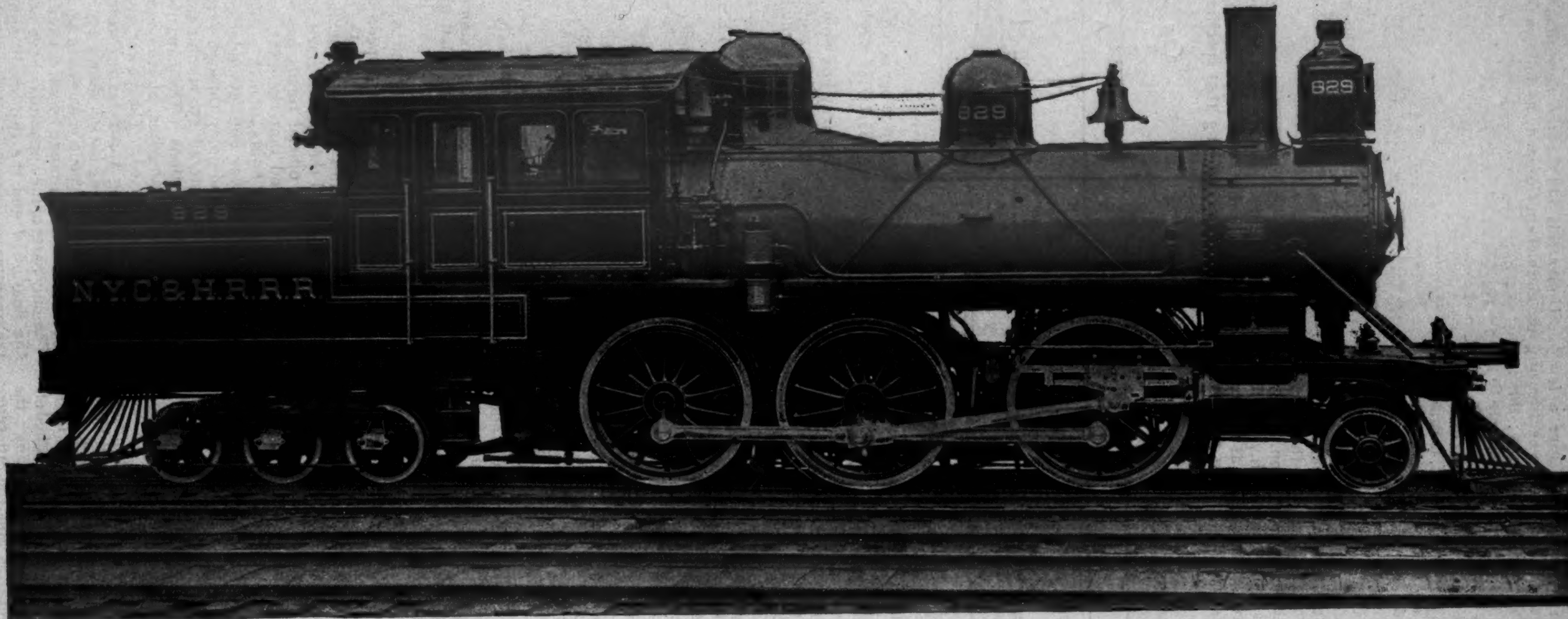
Cruiser No. 12 has not yet been named, and no title has been suggested for her beyond that of the *Pirate*, which has already been attached to her as a popular nickname.

TORPEDO TRIALS.

A trial of the Sims-Edison torpedo was held at Willet's Point near New York, August 12, the object being to test the steering qualities chiefly. The float of the torpedo was 28 ft. long and the torpedo itself 33 ft. long and 26 in. in diameter. The official report has not been published, but it is understood that the trial was very successful. It lasted about 4½ hours, and at a distance of about two miles the torpedo was entirely under control, turning in a radius of 250 ft. and going through various evolutions.

The engine registered 250 revolutions, and the dynamo reached 400 revolutions. The capacity of the dynamo is 1,800 volts and 30 ampères, of which only 1,300 volts and 23 ampères were used. The power absorbed by the propelling and steering apparatus registered 32 H.P.

The accompanying sketch shows a Sims-Edison torpedo. The body of the torpedo is shown in section. In operation the connections are made by wires from the shore dynamo. The only parts of the apparatus above water are the edge of the float *A A* and the two small signals *B B*, by which the operator on shore is enabled to follow the progress of the torpedo.



TANK LOCOMOTIVE FOR SUBURBAN TRAFFIC, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.]

NEW CONTRACTS.

The Secretary of the Navy has decided to award the contract for Cruiser No. 13 to the William Cramp & Sons Ship & Engine Building Company, of Philadelphia, for $2,690,000, that amount being $55,000 below the Company's first bid. The reasons given for this award were that, while the bid of the Bath Iron Works was the lowest, that Company could not complete the ship as soon as the Cramp yards; moreover, the Cramp Company was already building Cruiser No. 12, which is almost exactly the same ship as No. 13, and would thus have an advantage in time, having already a large number of patterns, etc., which could be used on the second ship.

A LOCOMOTIVE FOR SUBURBAN SERVICE.

The engraving given herewith is from a photograph of one of several new locomotives built by the Schenectady Locomotive Works for the New York Central & Hudson River Railroad. They were designed by Mr. William Buchanan, Superintendent of Motive Power of that road, for the suburban trains out of New York. The work on these trains is very heavy, owing to the numerous stops required, and the necessity of making quick time and frequent runs. The extent of this service and the necessity for making time will be appreciated when it is stated that from 3 P.M. to 7 P.M. a train leaves the Grand Central Station in New York every five minutes, on an average, on the Hudson River and Harlem divisions of the road, while if the trains of the New York, New Haven & Hartford, which also use the Grand Central Station, are added, the average headway is reduced to about three minutes.

This engine, it will be seen, is of the Hudson double-ender type, having a two-wheeled truck forward, six coupled driving wheels under the boiler, and a six-wheeled truck under the tank; the latter is carried on an extension of the frames. The rear driving-axle is under the fire-box.

The boiler is of the wagon-top type, and is built for a working pressure of 180 lbs. The barrel is 56 in. in diameter. The barrel and outside fire-box are of ½-in. steel; the circumferential seams are double riveted, and the horizontal seams are quadruple riveted, with welt strips inside. There are 254 iron tubes 2 in. in diameter and 11 ft. long. The fire-box is 108 3/16 in. long inside, 42⅜ in. wide, 64¾ in. deep at the front end, and 54¾ in. at the back. The fire-box plates are of 5/16-in. steel, except the crown-sheet, which is ⅜ in. and the tube-sheet ½ in. The water space around the fire-box is 4 in. in front, 3 in. at the back and sides. The crown-sheet is stayed by crown-bars 5 × ¾ in. in size and welded at the ends in pairs. The grate, for anthracite coal, is of water-tubes, with the necessary pull-out and shaking bars. The grate area is 31.9 sq. ft.; the heating surface is: Fire-box, 144.9 sq. ft.; tubes, 1,451.8 sq. ft.; total, 1,596.7 sq. ft. The smoke-stack is 15 in. inside diameter, and its top is 14 ft. 6 in. above the rail. The exhaust nozzles are double, and are 3⅜ in. in diameter.

The tank, which is carried on an extension of the frame as shown, has a capacity of 2,300 galls. of water. The coal-box will hold 2¾ tons of anthracite coal.

The cylinders are 18 in. in diameter and 22 in. stroke. The pistons are 5 in. thick, and the packing is the ordinary brass ring babbited and held out by springs. The piston-rods are 3¼ in. in diameter. The steam ports are 16 × 1¼ in.; the exhaust ports 16 × 2½ in. The valve motion is the ordinary link; the valves are the Richardson balanced, and have ¾ in. outside lap and 1/32 in. inside lap. The greatest travel of valve is 5½ in., and the lead at full stroke is 1/16 in. Piston rods and valve stems have the U. S. metallic packing.

The driving-wheels are 64 in. in diameter; the driving-axle journals are 7½ × 9 in. The front truck is a two-wheeled swinging bolster truck; the wheels are 30 in. in diameter, and the axle has journals 5½ × 9 in. The back truck is a six-wheeled swinging bolster truck, with 30-in. wheels; the axles have 4½ × 8 in. journals. The main crank-pins are 4½ × 4½ in.; the intermediate crank-pin 5 × 5 in., and the front and back crank-pins 4¼ × 3¼ in. The parallel rods have solid ends and bushings. The driving-springs are 40 in. between centers of hangers, and those of the main and back drivers are hung under the engine frame. The arrangement of the springs on the six-wheeled truck is shown by the engraving.

The transverse distance between the centers of cylinders is 7 ft. The main connecting rod is 7 ft. 4½ in. between centers. The total wheel-base of this engine is 35 ft. 7 in. The rigid wheel-base, which is also the driving-wheel base, is 12 ft. 9 in. The total wheel-base of the drivers and front truck is 20 ft. 4 in. The total weight of the engine ready for service, with tank full, but without coal, is 163,500 lbs., of which 16,000 lbs. are carried on the front truck, 95,000 lbs. on the drivers, and 52,500 lbs. on the back truck. The weight on the drivers is thus 15,833 lbs. per wheel.

Three of these engines have been in service for a short time, and have shown themselves so far very well adapted to their work.

NOTES ON COMBUSTION.

By C. Chomienne, Engineer.

(Continued from page 360.)

FIRE-BOXES.

Having considered the different qualities of coal, we now proceed to study the phenomena of combustion, and to analyze what happens in the ordinary fire-box of a boiler.

When air passes through a layer of ignited coal, its oxygen takes up carbon in different degrees according to the period of contact. This period, for the same layer of coal, depends upon the speed with which the air passes through it. The stronger the draft, the less time of contact and the less carbon is absorbed by the oxygen.

As the layer of coal upon the grate is never entirely homogeneous, each particle of air passes through it under different conditions of contact, and the composition of the resultant gases will vary from point to point. We find oxygen, carbonic oxide, carbonic acid and finally nitrogen, and to these gases are added the hydrocarbons resulting from distillation when the fire is charged with fresh coal. Let us see what is the theoretical quantity of air necessary for the combustion of 1 kg. of carbon.

In 100 parts by weight of carbonic acid there will be 27.273 of carbon and 72 727 of oxygen. The quantity of oxygen necessary to the combustion of 1 kg. of carbon will be

$$\frac{27.273}{72.727}=\frac{1}{x}, \text{ whence}$$

$$x=\frac{72.727}{27.273}=2.666 \text{ kg.}$$

The weight of one cubic meter of air at 0° (cent.) being 1.3 kg., a cubic meter of oxygen at the same temperature will weigh 1.1054 × 1.3 = 1.437 kg., and the volume of 2.666 kg. of oxygen will be:

$$\frac{1.437}{1.000}=\frac{2.666}{x},$$

$$x=\frac{2.666}{1.437}=1.855 \text{ cubic meters.}$$

Since 100 volumes of air include 21 of oxygen and 79 of nitrogen, the quantity of air necessary to the combustion of 1 kg. of carbon will be:

$$\frac{0.21}{1.0}=\frac{1.855}{x}$$

$$x=\frac{1.855}{0.21}=8.800 \text{ cub. meters.}$$

Applying the same calculation we find that 26.600 cub. meters of air will be required to burn 1 kg. of hydrogen. If we take a gas coal having 82 parts of carbon and 5.4 of

hydrogen per 100, to have a theoretically complete combustion, we will require for

Carbon	$0.820 \times 8.800 = 7.234$ cub. m.
Hydrogen	$0.054 \times 26.600 = 1.436$ " "
Total	8.670 cub. m.

It is not possible to fix absolutely the quantity of air necessary to combustion, which varies with the quality of the fuel. We can, nevertheless, say that to burn 1 kg. of coal of average quality, it will be theoretically necessary to supply about 8 cub. m. of air.

If we use only the quantity of air strictly necessary, it will require special conditions of combustion which are impossible to realize in practice. It would be necessary, in the first place, to have the coal in small pieces, all exactly of the same size, leaving a great number of passages through the burning mass in order to permit the air to pass through uniformly and to give up all its oxygen; but in practice the coal is in pieces of very unequal size, leaving consequently unequal and variable intervals. The layer of coal is of unequal thickness and the slag more or less porous.

If the air passages are not increased so as to admit a greater quantity of air than is absolutely necessary for combustion, a part of the carbon, instead of being completely oxidized and passing into the state of carbonic acid, is only partially burned and is transformed into carbonic oxide, and we know that these combustions produce widely different heating effects. The combustion of the same body is accompanied by the disengagement of very different quantities of heat according to the amount of oxygen with which it combines in the different cases. In fact, 1 kg. of carbon in passing into the state of oxide has produced experimentally 2,473 calorics or units of heat. Now we know that 1 kg. of carbon and 8 kgs. of oxygen will produce 14 kg. of carbonic oxide. In consequence, 1 kg. of carbon will produce $14 \div 6 = 2.333$ kg. of CO, and as 1 kg. of CO transformed into CO_2 develops 2,403 calorics, the 2.333 kg. of CO changed into CO_2 will give $2.333 \times 2{,}403 = 5{,}607$ calorics. Consequently the total number of units of heat developed by the combustion of 1 kg. of carbon will be $2{,}473 + 5{,}607 = 8{,}080$.

This would show that 1 kg. of carbon transformed directly into carbonic acid disengages the same quantity of heat as if it were first transformed into carbonic oxide and then into carbonic acid.

There is then a very great advantage in transforming all the carbon into carbonic acid, since under these conditions it develops 8,080 units of heat, while transformed into carbonic acid, which develops only 2,473, or less than one-third. If an insufficient supply of air is injurious to complete combustion of the elements of the coal, on the other hand, an excessive supply of air has the inconvenience of increasing the quantity of hot gases which are thrown out from the smoke-stack, which increases the loss of heat by the chimney, a loss which can increase to a much greater degree than the gain made by obtaining a more complete combustion.

Experience has shown, and it has been generally admitted in practice, with ordinary fire-boxes of steam boilers, that in order to reduce to a minimum the sum of the losses by incomplete combustion and by the chimney it is generally necessary to admit to the grate almost double the quantity of air theoretically necessary, because the oxygen being disseminated in the air, will not be completely absorbed in its passage through the burning coal.

The volumes which pass through the grate are also very variable, according to the moment of combustion. Thus when fresh coal is thrown upon the burning mass there is a rapid disengagement of gas which fills at once all the openings. The passage of air is partly interrupted, but it resumes its rapidity as fast as the smoke disappears and the coal is transformed into coke.

Some experiments on this head are reported by Mr. Combes, who states that he passed through the ash-box 5.340 cub. m. of air, and as the disengagement of smoke diminished the quantity of air entering increased until it was 19 cub. m., when the coal was transformed into coke; that is, when it had parted with its gases.

The current of air is then entirely insufficient during the moments following the charge of the furnace with coal and is too great at other times, but what we wish to produce is directly the opposite. There should be more air at the moment of the disengagement of smoke and less when that has ceased. The best method of remedying this is to burn the coal very carefully, firing in such a way that the production of gas may be as nearly constant as possible. This result may be obtained by firing frequently and with small quantities of coal from the front of the grate where the temperature is higher. The coal then gives up its gases slowly and they burn as soon as produced, and when it is almost transformed into coke, it can be pushed forward in the fire-box where the combustion is completed. This careful method, however, is hardly possible except with the rich or oily coals, the use of which in boilers is becoming less and less general. It is for this purpose that we use the dead-plate, the invention of which is attributed to Watt, which is placed between or at the end of the grate bars, and is a plate upon which coal is placed for distillation. The dead-plate was formerly made much larger than it is now, when it has been reduced in size and is practically only used for the purpose of making a division between the fire and the front plate of the fire-box.

When we use dry coals, which is the most frequent case, the coal can be thrown on uniformly over the whole grate. For a fire-box burning, say, 100 kg. an hour, it would be sufficient to fire about once in 12 minutes, putting in 20 kgs. at a time, and this work would not be excessively fatiguing for the firemen. With a large fire-box burning, say, 200 kg. an hour, and supplied with two doors, the charges could be made alternately at either door and at intervals of about six minutes.

As the grate becomes loaded with slag, the air passes through with some difficulty; especially if the slag is porous, the fuel burns imperfectly and the smoke-stack throws out black smoke with colorless carbonic oxide. In this case it becomes necessary to open the air passages in such a way as to make up for the insufficient supply by the increased draft.

If we use a harder coal with less flame, we avoid the inconvenience of this irregular supply of air, because this fuel will not form slag and will not give out much gas.

According to certain experimenters, the chemical combinations in the fire-box are more complete as the draft is stronger, but with the essential condition that the layer of coal on the grate should be in relation to the activity of the draft. If the fire is too thin, much air will pass through without giving up its oxygen, the tubes or flues will be cooled and heat will be carried off. With a strong draft it is, then, advantageous to burn the coal in a thicker layer.

According to Messrs. Thomas and Laurens, carbonic oxide is only formed when the combustion is slow; that is, when the draft is weak. Their observations have been confirmed by the recent experiments of M. Scheurer-Kestner, of Mulhouse, who has found that with a supply of air more than 50 per cent. in excess of the theoretical quantity, there is still some formation of carbonic oxide, and when the excess of air is only from 6 to 7 per cent., this proportion is enormous and can be increased, as we will see below, to 6 per cent.

Forced draft suits very well hard coals with little flame, especially when we use this coal as it comes without screening. When it is fine it should be mixed with coal tar or some similar material, in order to furnish the gaseous element which is wanting.

M. Poupardin has recently published an account of some experiments which he has made on the use of heated air beneath the grates, and he has succeeded in proving that there is an economy in this which varies from 5 to 7 per cent. This air is heated by means of the hot gases passing into the smoke-stack, and its temperature can be raised to 50° Cent. With heated air, the tubes are not cooled to the same degree, and we obtain a shorter and whiter flame. At the same time the production of smoke is very much diminished.

ANALYSIS OF THE PRODUCTS OF COMBUSTION.

The analysis of the gases given out by a chimney shows that the composition of the gaseous products of combustion

varies very greatly, as the smoke is lighter or darker. The materials composing this smoke are carbonic acid, oxygen, carbonic oxide, hydrogen, nitrogen, and lastly solid carbon in a very finely divided state, held in suspension in steam and the other gases. The quantity of water formed can be estimated as follows: If we take coal having 82 parts of carbon, 5.4 hydrogen and 12.6 of oxygen in 100, the production of the combustion of this coal in water will be $(8 \times 5.4) + 5.4 = 48.6$ kg.

Each unit of weight of hydrogen, in fact, combines during combustion with 8 units of oxygen in order to form 9 units of water in weight. This figure of 48.6 kg. represents about 80 cub. m. of steam at a pressure of 0.76 and at 100° Cent.

As to the black carbon which is thrown out by the chimney, it is found without doubt chiefly in solution in the hydrogen and mixes up in the immense quantity of steam which we have just estimated. It is deposited as soon as the temperature of the smoke is sensibly lowered, which explains the fact that we find it only in the passages beyond the boiler and near the chimney. If we use a strong draft, it is carried through and is deposited beyond the chimney, on neighboring surfaces.

In order that the results of the analysis of the gases may be exact, it is necessary, as M. Scheurer-Kestner has shown:

1. That the gases be taken as far as possible from the fire-box in order that the mixture, which is very different when it leaves the fire-box, may be as homogeneous as possible. It has been observed that in taking the gases in the fire-box we find a quantity of carbonic oxide much greater than that which exists in the same gases when they have cooled somewhat.

2. The gases must be taken at uniform intervals during a considerable time. This is simply saying that to take the gases out irregularly and for a short time only has no value whatever when we seek to determine the average composition.

We give below experiments made on a boiler with three flues with cylindrical reheaters. The principal dimensions are as follows: Length of boiler, 6.60 m.; diameter, 1.20 m.; heating surface, 12 sq. m.; diameter of flues, 0.50 m.; heating surface of flues, 28 sq. m.; total heating surface, 40 sq. m.; length of the superheaters, 7.90 m.; diameter, 0.50 m.; surface, 71 sq. m.; length of the grate, 1.28 m.; width of the grate, 1.40 m.; space between grate bars 8 mm.; total surface of the grate, without dead-plates, 1.79 sq. m., of which 1.28 sq. m. are occupied by the grate bars themselves and 0.51 sq. m. by the air spaces between them.

The coal used had the following composition: Cinders, 21; carbon, 70; hydrogen, 4; oxygen, 4; nitrogen, 1, in 100 parts, and the quantity of air theoretically necessary to burn 1 kg. was 7.145 cub. m. The gases were taken at the end of the boiler in order to avoid any mixture of exterior air. The results of these analyses are given in the accompanying table:

No. of Analysis.	Air in Excess.	Air introduced under the Grate.	Composition of the Gases in 100 parts. Incombustible Gases. Nitrogen.	Incombustible Gases. Carbonic Acid.	Incombustible Gases. Oxygen.	Combustible Gases. Carbonic Oxide.	Combustible Gases. Vapor of Carbon.	Combustible Gases. Hydrogen.	Coal burned per hour per sq. dcm.	Max. Temperature of the Gases.	Quantity of Coal at a Charge.	Interval between Charges.	Loss of Carbon, in Oxide and Hydrocarbons.	Loss of Hydrogen, in a free state and in Hydrocarbons.
	Per cent.	*Cub. m.*							*Kilog.*	*Deg. Cent.*	*Kilog.*	*Min'ts*	*Per cent.*	*Per cent.*
12	6.66	6.504	80.38	14.87	1.41	0.84	1.15	1.35	0.400	119°	7	5	4.1	30.9
11	10.47	6.803	80.60	14.16	2.18	0.97	0.98	1.11	0.470	128°	14	8	5.0	26.9
9	13.32	7.960	80.66	14.63	2.80	0.86	0.49	0.56	0.470	126°	7	4	5.2	15.8
13	17.61	8.719	81.52	13.34	3.77	....	0.46	0.91	0.400	135°	7	3	6.1	17.5
14	20.94	8.540	80.23	13.43	4.42	0.24	0.32	1.41	0.400	?	14	10	1.5	31.0
8	26.18	9.257	80.34	12.89	5.53	?	0.28	0.96	0.230	93°	7	8	3.9	19.7
10	42.84	11.718	79.76	10.87	8.99	?	0.19	0.19	0.925	156°	7	2	3.4	4.7
7	53.78	15.393	79.86	8.23	11.35	?	0.04	0.52	0.166	94°	6	10	0.9	17.7

In No. 7 it was difficult to keep the openings in the grate covered with so small a quantity of coal, and for this reason a considerable excess of air is found. In No. 11 and No. 12 the volume of air admitted per kilogram of coal was less than the quantity theoretically necessary to complete combustion—6.86 and 6.50 cub. m. instead of 7.145.

These experiments have established the following facts:

1. Among the gaseous products of combustion, even when there has been always an excess of oxygen, we always find combustible gases, carbonic oxide, hydrocarborns and free hydrogen.

2. In varying the draft and consequently the admission of air to the grate, the loss with the coal used may vary from 6 to 18 per cent. with 8 to 9 cub. m. of air per kilogram of coal; 4 to 6 per cent. with 10 to 12 cub. m., and 1.5 per cent. with 15 cub. m.

The average of the tests made gives the following as the division of the units of heat developed:

Calorics in the steam produced		63.6
" carried into the chimney by the gases		5.1
" lost by incomplete combustion of gases	4.9	5.3
" lost in the soot deposited	0.4	
" of the steam carried off in the smoke		3.0
" not recovered		23.0
Total heat from the coal		100.0

These results have been obtained under exceptional circumstances, and with good firemen. We learn from them what may be the loss in ordinary working when probably the boiler is not placed in the best way, when the fireman is ignorant and left to himself. We see that the loss by incomplete combustion of gases is 5.3—that is, 8.3 per cent. of the useful heat. We may estimate that this loss will generally exceed 15 per cent., that it often reaches 20 per cent., and that it is never less than 10 per cent., if the coal is not anthracite.

The loss of 23 per cent. in units of heat not found was reduced to 17 per cent. with English coal, giving very little smoke and only traces of combustible gases. Even when reduced to 17 per cent., however, the loss is still great, and considering all the facts recorded, we can only attribute it to the radiation of heat to the masonry walls of the fire-box. Boilers with interior fire-boxes, like marine boilers, show some loss by cooling and radiation from the outside surfaces, but it is much less considerable than with the ordinary cylindrical boiler set in masonry.

(TO BE CONTINUED.)

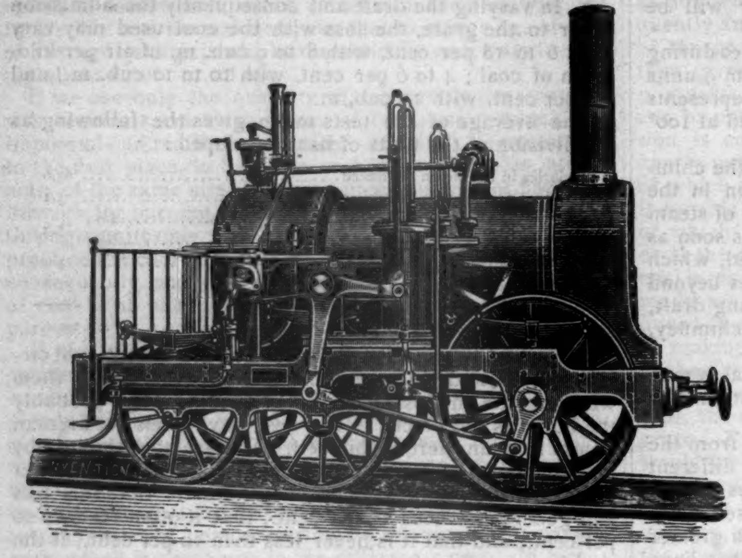
A BIT OF LOCOMOTIVE HISTORY.

THE accompanying engravings and the description below have been sent us by Mr. Clement E. Stretton of Leicester, England, and are taken from an article published by him in the London *Invention*. The first is from a photograph—believed to be the only one now in existence—of the locomotive *Earl of Airlie*, No. 1, which is described as follows: "This engine was built by Carmichael & Company, of Dundee, Scotland, and commenced work upon the Dundee & Newtyle Railroad, September, 1833, and during the same month the *Lord Wharncliffe*, No. 2, was completed; followed by the *Trotter*, No. 3, in March, 1834.

"These three engines were in every respect similar, and had a single pair of driving-wheels 4 ft. 6 in. in diam-

eter placed in front, and a four-wheeled bogie, the cylinders being vertical, 11 in. in diameter, and the stroke 18 in. Weight of engine in working order without tender, 9 tons 10 cwts.; cost of engine without tender, £700; gauge of railway, 4 ft. 6 in.

"The *Earl of Airlie* appears to have worked satisfactorily until 1850, when it was employed to pump water as a stationary engine. In 1854 Mr. Allan, when Locomotive Superintendent of the Scottish Central, had it properly cleaned, painted and photographed, and it is from this photograph that our illustration is produced."

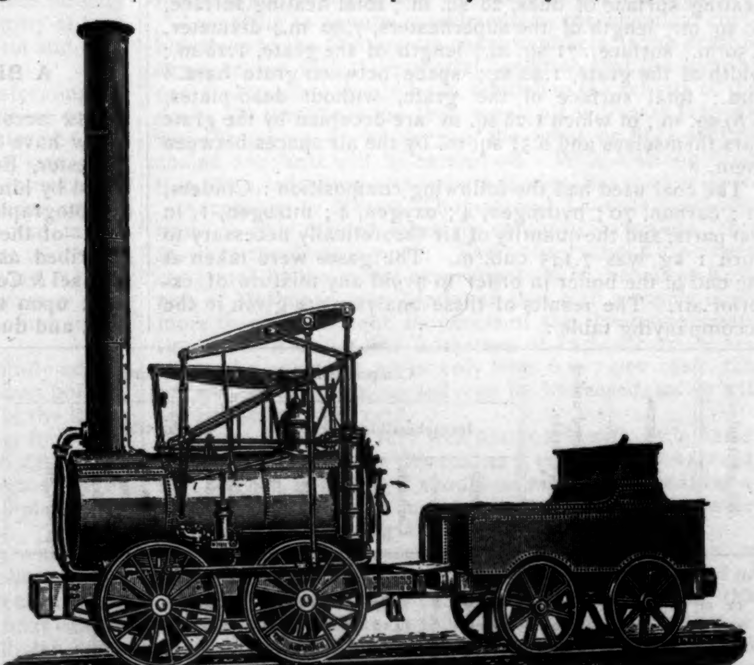


LOCOMOTIVE FOR THE DUNDEE & NEWTYLE RAILWAY, 1832.

The general design of the engine, with the truck, with its upright cylinders and the bell-crank used to make connection with the driving-wheels, is well shown in the cut.

The second illustration shows a still older engine, which Mr. Stretton describes as follows: "Messrs Foster, Rastrick & Company, in 1829, constructed an engine at their works, Stourbridge, for the Shutt End Railroad, which extends from the Earl of Dudley's Colliery at Kingswinford to the Staffordshire & Worcestershire Canal; this locomotive was named *Agenoria*, and opened the line on Tuesday, June 2, 1829.

"This engine has upright cylinders working half-beams, thus reducing the stroke of the pistons to the cranks. The cylinders are 7½ in. diameter, with a stroke of 3 ft. There is a parallel motion to the piston-rod, and the feed-pump is worked from one of the half-beams. The fire-grate is within a large tubular boiler, branching into two tubes, with the chimney at the end of the boiler, the barrel of the boiler being 10 ft. long and 4 ft. diameter. The eccentrics for driving the slide valves are loose upon the axle, with a clutch to drive either way, and there is hand-gear to the valves to cause the axle to turn half round to bring the required backward or forward clutch into action. The exhaust steam is discharged into the chimney, which, it may be mentioned, is of unusual height. *Agenoria* continued in regular work for fully 30 years, and is now preserved in the South Kensington Museum."



LOCOMOTIVE "AGENORIA," BUILT IN 1829.

It will be observed that the *Agenoria* must have been built immediately before or after the *Stourbridge Lion*, which the late Horatio Allen bought from Foster, Rastrick & Company in 1829, for the Delaware & Hudson Canal Company, and which was the first engine run in this country. Very probably the two were in the shop about the same time. Those who have seen drawings or engravings of the *Stourbridge Lion*,* will at once see that the *Agenoria* was of almost identical design. It is interesting to know that this early specimen of locomotive construction is still preserved as a relic.

THE HATTERAS LIGHTHOUSE.

THE great caisson which was to serve as the foundation for the lighthouse on Diamond Shoal, off Cape Hatteras, was towed into position successfully on July 1. Operations for sinking were begun, with fair prospects of success, but on July 8 a severe storm came up and the caisson was overturned into deeper water. When the storm was over it was found that the great cylinder was in such a position that its recovery was practically impossible, and the contractors, Anderson & Barr, have decided to build a new one. The loss was partly due to the fact that the water over the shoal was deeper than had been expected, and the foundation looked for was not found. The sandy bottom at that point is constantly shifting, and the depth of water was from 22 to 25 ft., where only about 10 or 12 ft. had been shown by previous surveys.

The caisson lost was a steel cylinder 54 ft. in diameter and 50 ft. long. It was built at Norfolk and towed to the spot where it was to be sunk. The work of getting it into position was accomplished with less difficulty than had been expected.

The contractors will build a new caisson and resume the work as soon as possible. This will take some time, however, especially as it will be impossible to place the caisson during the fall or winter, owing to the constant stormy weather and heavy seas along the coast.

Once in position, the caisson is to be filled in with concrete and surrounded by riprap. The lighthouse will be built on top of it when the foundation is finished. Owing to the constant interruption by stormy weather, it is impossible to say when the lighthouse will be completed, but the new caisson cannot be finished and put in place before next summer, so that at least one year's delay has resulted from the accident.

* See the RAILROAD AND ENGINEERING JOURNAL for February, 1890, page 85.

THE MORANDE BRIDGE OVER THE RHONE.

THE accompanying illustration, fig. 1, which is taken from *Le Genie Civil*, shows the new Morande Bridge over the Rhone at Lyons, France. The bridge is an arch bridge of three spans resting on two abutments and two piers of granite masonry. The piers are built upon caissons sunk by the compressed air process, the foundations being about 45 ft. below low water. The arches at the center have a clear height of 26 ft. above high water.

Fig. 1.

THE MORANDE BRIDGE OVER THE RHONE.

Each span is composed of eight iron trusses, spaced 8.5 ft. between centers, except the two outside trusses, which are 10.8 ft. from the adjoining inside truss. The total width of the bridge is 65.6 ft., divided into a roadway 36 ft. in width and two sidewalks, each 14.8 ft. wide. The central arch has a span of 221 ft., a rise of 14.6 ft., and a radius of 426.8 ft.; the two side arches have each a span of 210 ft.; a rise of 13 ft., and a radius of 418.5 ft. The division of the total space between the arches was calculated in such a way as to equalize the pressure on the piers at an average temperature and the strains on the adjoining arches. The profile of the bridge roadway is an arc of a circle of 17,075 ft. radius, and the grade at the point where it meets the quay on either side is 0.2 per cent. The arch trusses rest at either end upon inclined bed-plates of iron, placed on suitable beds on pier or abutment.

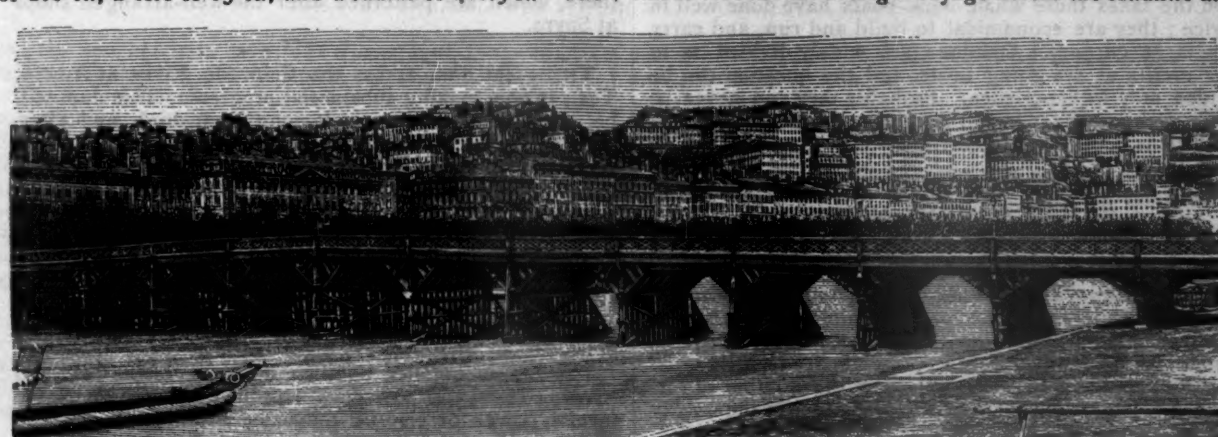


Fig. 2.

The bridge carries one of the chief avenues of the city, on which there is a large traffic, including many heavy wagons. The water and gas-pipes are suspended beneath the roadway.

Fig. 2 shows the old bridge which is replaced by the new structure. This bridge was built by the Architect Morande in 1774, and was a wooden structure, consisting of 17 spans, varying from 35 ft. to 45 ft. These spans were simple trusses entirely of oak, and rested on piers composed of groups of oak piles driven into the bed of the river, which is chiefly gravel. This bridge had stood over 100 years, but its width, only 42 ft. in all, and its sharp grades were a serious obstruction to travel, and it had at last begun to show signs of weakness. Its numerous piers, moreover, and the rip-rap used to protect them, constituted an impediment to the boats navigating the river and an obstruction to the free passage of the water in times of flood. The bridge, nevertheless, had done good service and had a long life for a wooden structure.

THE "WHALE-BACK" STEAMER.

THE "whale-back" steamer *Charles W. Wetmore*, built by the American Barge Company, at Duluth, Minn., has succeeded in making a voyage across the Atlantic and back in spite of some unfavorable predictions. The *Wetmore*, after a trip through the Lakes and down the St. Lawrence, left Montreal with 90,000 bushels of grain on board, and reached Liverpool after a voyage of 15 days. No attempt at speed was made, and the total consumption of coal was only 230 tons. From Liverpool she sailed to New York, and is now loading machinery at the Continental Iron Works. When ready she will sail for a voyage around the Horn to Tacoma, Washington, and will then probably be employed on the Pacific coast.

The *Wetmore* is very similar in construction to the *Colgate Hoyt*, which was described and illustrated in the JOURNAL for September, 1890, page 427. The accompanying illustration we have reproduced from the London *Engineer* because it shows very well the general form and design of the boat. She is 265 ft. long, 38 ft. beam and

24 ft. deep, and can carry 3,000 tons of grain on 16½ ft. draft. Arrangements for carrying 800 tons of water as ballast are provided. The general form is shown by the cut; there is no deck really, and three turrets, the two after ones being connected by a platform or deck. There is a collision bulkhead forward and another bulkhead in front of the engine-room aft, the space between the two bulkheads being entirely free and open for cargo.

THE "WHALE-BACK" STEAMER "CHARLES W. WETMORE."

The engine of the *Wetmore* is a compound, with cylinders 26 in. and 50 in. in diameter and 42 in. stroke. They have worked up to 800 H.P. Steam is furnished by two steel boilers 11½ ft. in diameter by 11½ ft. long, which carry a working pressure of 125 lbs.

On the lakes these whale-back boats have done well in service; they are economical to build and run, and carry very large cargoes. Opinions are widely divided as to their merits as sea-going boats, and the question can be decided only by experience. Probably they can never be made good passenger boats, but they may find a very useful place as ocean freight carriers.

SOME CURRENT NOTES.

IN pig iron production, according to the tables of the *American Manufacturer*, there is a continued increase. On August 1 there were 302 furnaces in blast with a weekly capacity of 174,502 tons; an increase of five furnaces and 7,078 tons capacity over July 1. As compared with August 1, 1890, there is a decrease of 19 in the number of furnaces in blast, but an increase of 10,435 tons in the weekly capacity.

The gain in August was almost entirely in the bituminous and coke furnaces, the anthracite and charcoal furnaces showing but little change.

ON the Grazi-Tsaritsin Railroad in Russia, where liquid fuel is used, Mr. Thomas Urquhart writes to the London *Railway Engineer* that on the freight trains the average consumption, by careful experiment, has been 0.04824 lb. per ton-mile of gross train, including engine and tender, or 0.0888 lb. per net ton-mile of freight carried. On passenger trains, at an average speed of 25 miles an hour, the consumption was 0.0636 lb. per ton-mile of train, including engine and tender. The fuel used is petroleum from the Baku wells.

ONE of the best pieces of new railroad ever opened for traffic in this country will be the Lehigh Valley line from Waverly to Buffalo. It is double track throughout, has been located and built with great care, and has no grades over 21 ft. to the mile, making it an excellent freight line. It will be opened by May, 1892, at which time the present contract, under which the Lehigh Valley trains run from Waverly to Buffalo over the Erie tracks, will expire. The line could be brought into use sooner, but the road-bed will then have passed through one winter, and will be well settled, and an opportunity will be given to remedy any defects. The Lehigh Valley now has 41 locomotives in service on the Erie tracks, but on the new line a considerable increase in traffic can be handled with the same motive power. The Company has had terminal facilities of its own in Buffalo for some years; and has lately built shops there, which are patterned after the well-arranged shops at Sayre.

THE great dam across the Colorado River at Austin, Tex., is now making substantial progress. This dam will be, when completed, 1,150 ft. long, 60 ft. high, and 18 ft. wide at the top. The up-stream face is of limestone, and is vertical; the down-stream face is of Texas granite, and the interior is rubble masonry, of small stone and cement. There will be about 9,000 cub. yds. of granite, 6,800 cub. yds. of limestone, and 55,000 cub. yds. of rubble in the dam. The estimated cost of the dam itself is $465,000; to this is to be added that of the gate-house, the canal which is to convey the water to the manufactories, and other auxiliary works, which is estimated at about $800,000 more.

The dam is intended to utilize the power of the Colorado River. The water power will run the electric light plant, furnish power for electric railroads, and for pumping the water-supply of the city, and leave a surplus of some 13,000 H.P. for the use of factories. It is about two miles above the city of Austin, and the natural conditions are very favorable, as the river there runs between high bluffs and the bed is of rock, so that very little excavation is required to find a solid foundation. It will be the largest power dam yet built in this country.

ANOTHER large dam is under construction in California, where the Bear Valley Irrigation Company has undertaken to form a large reservoir in a mountain valley or basin known as the Nuevo Laguna. The dam closing the outlet of this valley will be of earth riprapped on the up-stream face, and will only be 20 ft. in height and 400 ft. long. It will be 150 ft. through at the base, and will not cost over $150,000. In addition to the water brought down by the San Jacinto, the surplus waters of the Whitewater and Santa Ana rivers can be turned into the basin;

it is thought also that an additional supply can be had by boring artesian wells. The supply from the rivers, as stored by the dam, will be sufficient, according to the company's estimate, to irrigate 125,000 acres of land. It is expected that the dam will be completed in time to store the supply from next winter's rains.

THE Rapid Transit Commission in New York has recommended an additional underground line, to diverge from the main line already proposed at Union Square and thence running under Madison Avenue to 96th Street. The low ground north of that point will be crossed by a viaduct, on private property 100 ft. from the avenue to 134th Street, where the Harlem River will be crossed by a bridge; north of the river no definite line is laid down. Like the main line the new one is to have four tracks, both in the tunnel and on the viaduct, and the motive power will be the same.

The Commission's engineers have nearly completed the surveys and plans for the main line recommended some time ago. As heretofore stated, the plans are for four tracks underground from the Battery to Fort George, above High Bridge. From that point to Kingsbridge, the northern point of Manhattan Island, and thence to the city line the road will be alternately in tunnel and on viaduct, according to the nature of the surface, which is very uneven.

THE United States Circuit Court in New York has given a decision sustaining the validity of the Edison patents on incandescent lights. This decision practically gives Mr. Edison a monopoly in incandescent lights. The case will be carried up to the Supreme Court.

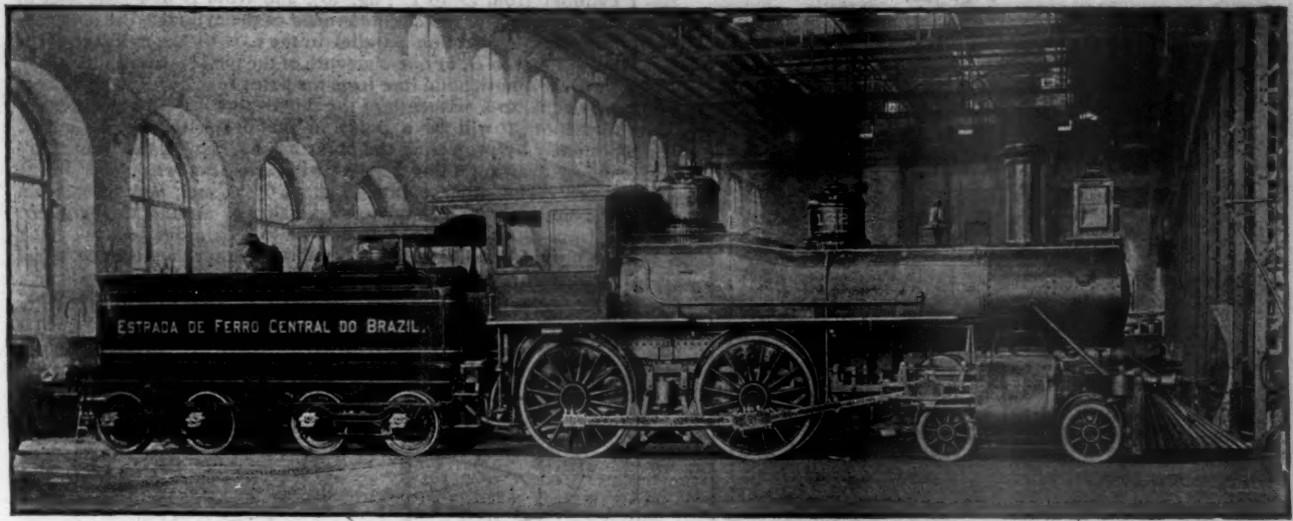
A FOUR-CYLINDER COMPOUND PASSENGER LOCOMOTIVE.

THE accompanying illustration, which is from a photograph taken in the shop, shows a four-cylinder compound locomotive of the Vauclain type, built by the Baldwin Locomotive Works, in Philadelphia, for passenger service on the Central Railroad of Brazil. The engine is of the ordinary eight-wheel, or American pattern, with four driving-wheels coupled and a four-wheeled truck.

The road is of 5 ft. 3 in. gauge. The high-pressure cylinders are 11½ in. in diameter and the low-pressure cylinders 19 in., all being 24 in. stroke. The driving-wheels are 66 in. in diameter, having Krupp steel tires 2½ in. thick. The driving-wheel-base is 8 ft. 6 in., and the total wheel-base of the engine is 23 ft. 0¾ in. The total weight in working order is 92,000 lbs., of which 60,000 lbs. are carried on the drivers and 32,000 lbs. on the truck.

The boiler is of the wagon-top pattern, and is of ½-in. steel, the barrel being 54 in. in diameter at the smoke-box end; the smoke-box is extended. There are 219 tubes 2 in. in diameter and 11 ft. 6 in. long. A departure from the usual practice is seen in the fire-box, which is of copper, except the crown-sheet. The side and back sheets are ½ in. thick, and the tube sheet ⅞ in. The crown-sheet is of ⅜-in. steel, and is supported by crown-bars in the ordinary way. There is a fire-brick arch supported by water-tubes. The grate is of water-tubes with intermediate pulling-bars. The fuel used will be Cardiff coal imported from England, which is in general use on the Brazilian lines, the country itself producing no coal.

As will be seen from the engraving, the high-pressure cylinder is placed above the low-pressure. The valves are piston valves of the Vauclain pattern, with a shifting-link motion. Both piston-rods are connected to the same cross-head, which is of wrought iron.



FOUR-CYLINDER COMPOUND LOCOMOTIVE, VAUCLAIN PATTERN.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

The driving-axles are of Siemens-Martin steel, and have journals 7½ in. in diameter and 8½ in. long. The bearings are of phosphor-bronze.

The truck is a swing-bolster truck with four 30-in. wheels; the wheels are cast-iron centers with steel tires. The axles are of steel, with 5 × 9-in. journals.

The tender is carried on two trucks, each having four 36-in. chilled wheels. The tender frame is of iron. Both trucks are center-bearing, and have iron frames. The axles are of steel, with 4 × 7-in. journals. The tank will hold 3,000 galls. of water. The weight of the tender, with a full load of water and coal, is 66,000 lbs.

It may be noted that the ratio between the high-pressure and low-pressure cylinders is 1 : 2.73.

A large number of the Vauclain compound locomotives are now in progress at the Baldwin Works, of which the engine illustrated is one of the best examples.

Foreign Naval Note.

IN a recent trial in France, before a commission of Russian officers, ten rounds were fired from a 15-cm. Canet gun in 100 seconds. This 15-cm. gun is 45 calibers in length; the projectile weighs 88 lbs., and the charge used is from 21 to 26.5 lbs. of smokeless powder. On a second trial, using powder charges of 22.2 lbs., seven rounds were fired in 54 seconds. With a projectile weighing 88 lbs. and a powder charge of 24.3 lbs., a muzzle velocity of 2,497 ft. was reported. A 12-cm. Canet gun, 45 calibers in length, fired nine rounds in 45 seconds; the projectiles weighed 44.5 lbs., and the powder charges were 12.1 lbs. With a shell weighing 46.8 lbs. and a charge of 12.1 lbs. of powder in the 12-cm. gun, a muzzle velocity of 2,487 ft. was reached.

THE ESSENTIALS OF MECHANICAL DRAWING.

BY M. N. FORNEY.

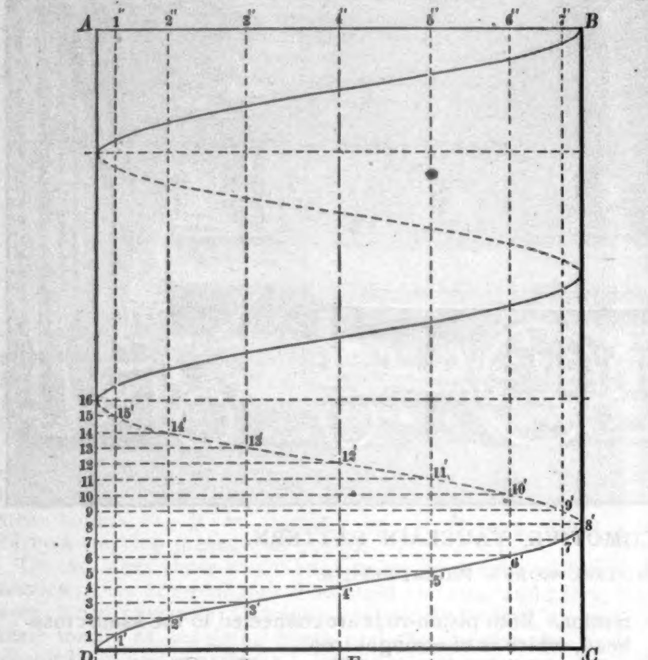
(Continued from page 376.)

CHAPTER XII.—(Continued.)

THE HELIX.*

THE helix or, as it is sometimes though improperly termed, the spiral, is the curve described upon the surface of a cylinder by a point revolving round it, and, at the same time, moving parallel to its axis by a certain invariable distance during each

Fig. 306.



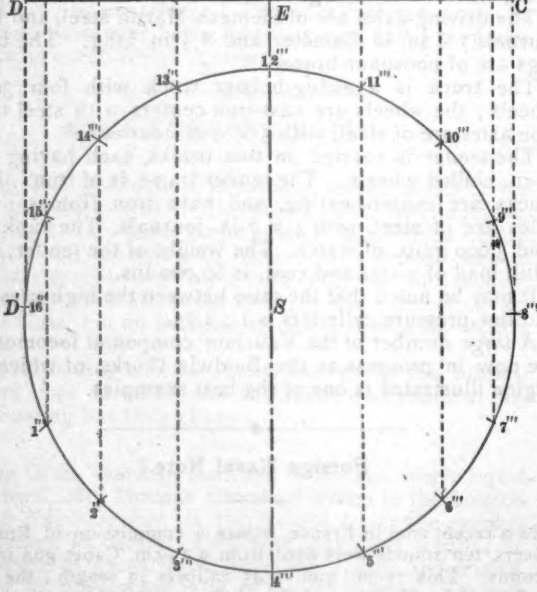


Fig. 307.

revolution. Thus the outlines of the thread of a screw and of what are called spiral springs form helixes.

Thus let it be supposed that the cylinder *A B C D*, fig. 306, has been placed in a lathe with its axis coincident with the lathe "centers," and a sharp-pointed turning tool is placed in contact with the surface of the cylinder at *D*, and that while the cylinder turns one revolution the tool moves from *D* to 16 at a uniform speed. The point of the tool would then describe a helix *D*, 1′, 2′-8′-16 on the surface of the cylinder, which would be of the form of the thread of a screw. The distance *D* 16 which the curve advances on the cylinder during each revolution, as described in Chapter VI, is called its pitch.

PROBLEM 114. *Required to draw a projection of a helix which is described around a cylinder.*

If *A B C D*, fig. 306, be the cylinder, then if the helix begins at *D* and *D* 16 is equal to the pitch, divide the latter into any even number of equal parts—in this case 16. Then on the center line 4″ *E* extended, and from any convenient point, as *S*, fig. 307, for a center, draw a circle whose diameter is equal to that of the cylinder, and divide its circumference into the same number of equal parts, 1‴, 2‴, 3‴, 4‴, etc., as the pitch has been divided into. Project these points in fig. 306 by vertical lines 1‴ 1″, 2‴ 2″, 3‴ 3″, etc., to *A B*. In winding around the cylinder from *D′* to 1‴, fig. 307, and from *D* to 1′, fig. 306, or one-sixteenth of the circumference of the cylinder, the helix has moved in a direction parallel to the axis of the cylinder a distance equal to *D*, or one-sixteenth of the pitch. Consequently, if we draw a horizontal line from the point 1—whose distance from *A* is equal to a sixteenth of the pitch—to 1‴ 1″, the point of intersection 1′ will be a point in the projection of the curve, Similarly by projecting the point 2‴, fig. 307, by the line 2‴ 2″ and by drawing a line 2 2′, we will have another point 2′ in the curve. The other points 3′, 4′, 5′, 6′, 7′, etc., may be laid out in a similar way. In advancing half way around the cylinder, or from *D* to 8′, in fig. 306, and *D′* to 8‴, in fig. 307, the helix has moved parallel to the axis of the cylinder a distance equal to half the pitch. From 8′ to 16, in fig. 306, and 8‴, 9‴, 10‴-*D′*, in fig. 307, it has advanced another half of the pitch.

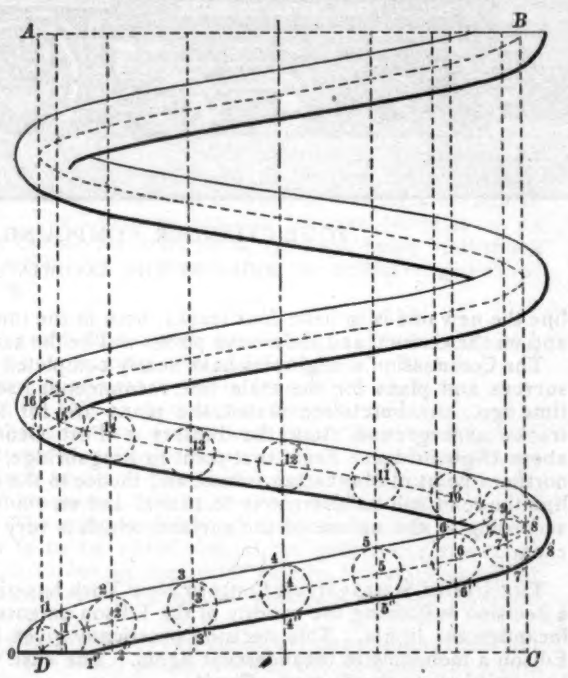


Fig. 308.

This latter portion of the curve is behind the cylinder in fig. 306, and is therefore represented by a dotted line, 8′, 9′, 10′-16, and is of exactly the same form as *D*, 1′, 2′-8′, but is reversed in position. It is drawn in the same way as has been described. As the projection of each succeeding revolution of the helix is the same as the first, if we make a template of *D* 1′ 2′-8′, all the other convolutions of the curve can be drawn from it.

PROBLEM 115. *To draw the projection of a helical spring.*

Let it be supposed that the spring is made of a round bar of steel, and that the diameter of the helix, measured from center to center of the steel, is the same as that of the cylinder shown in fig. 306, and that the pitch is also the same as that of the helix in this figure; then the first thing to do is to draw a helix *D*, 1′, 2′-8′, 16′, fig. 308, representing the center line of the steel bar. Next, with a radius equal to half the diameter of the bar, describe circles from the points *D*, 1′, 2′, 3′, etc., and draw lines 0, 1, 2, 3, 4, etc., and 1″, 2″, 3″, etc., tangent to these circles. The lines thus drawn will represent the outline of the spring.

* Draw the figures in this chapter double the linear scale to which they are engraved.

Fig. 309.

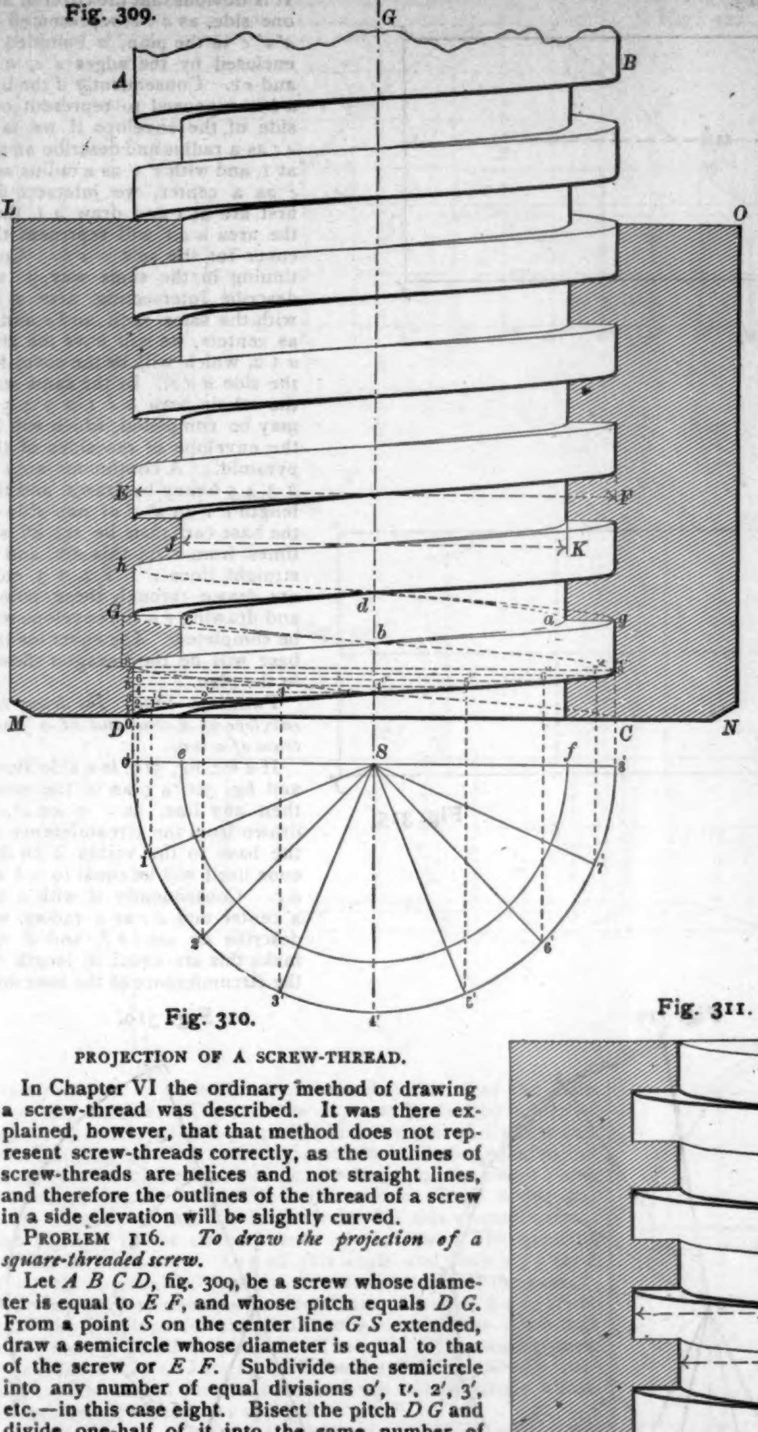


Fig. 310.

PROJECTION OF A SCREW-THREAD.

In Chapter VI the ordinary method of drawing a screw-thread was described. It was there explained, however, that that method does not represent screw-threads correctly, as the outlines of screw-threads are helices and not straight lines, and therefore the outlines of the thread of a screw in a side elevation will be slightly curved.

PROBLEM 116. *To draw the projection of a square-threaded screw.*

Let *A B C D*, fig. 309, be a screw whose diameter is equal to *E F*, and whose pitch equals *D G*. From a point *S* on the center line *G S* extended, draw a semicircle whose diameter is equal to that of the screw or *E F*. Subdivide the semicircle into any number of equal divisions 0′, 1′, 2′, 3′, etc.—in this case eight. Bisect the pitch *D G* and divide one-half of it into the same number of equal parts 0, 1, 2, 3, etc., as the semicircle has been divided into. Project vertical lines from the points of division 1′, 2′, 3′, etc., in the semicircle, and horizontal lines from 1, 2, 3, etc., the points of division of the pitch; then the points of intersection 1″, 2″, 3″–8″ will be points in the projection of the screw-thread. As all the threads are alike, by making a template of the curve 0, 1″ 2″–8″ the outline of all the other threads can be drawn with it if the lines *A D* and *B C* are each subdivided into divisions equal to half the pitch. The curves *a b* and *c d*, which represent the root of the thread, or rather its junction with the body of the screw, may be drawn by constructing a helix on a cylinder whose diameter is equal to *J K*, or the diameter of the screw at the root of its thread. To do this a second circle is drawn from the center *S*, whose diameter *e f* is equal to *J K*. The method which has been explained for drawing the outline 0, 1″ 2″–8″ must then be employed for drawing *a b* and *c d*.

In fig. 309 a section *L M N O* of a nut is shown on the screw, an outside view of the screw being represented. In this view the edges 0–8″ and 8 *g* of the thread which are nearest to the observer are shown. In making a half of a revolution the thread would advance from *D* to 8″, and in turning completely around the screw it would pass behind the screw and would advance from 8″ to *G*. The outside edges of this part of the thread which is behind the screw are represented by the dotted lines 8″ *b G* and *g d h*. It will be noticed that these incline the reverse way to the portion of the thread nearest to the observer. If now we were to remove the screw from the section of the nut and show the latter without the screw, the grooves in the nut in which the threads work would be seen, which are counter-parts of the thread. Consequently in showing such a section of a nut its thread is represented as shown in fig. 311. The construction for delineating the lines which represent the roots of the thread is shown in this and the following figure, which will require no further explanation.

CHAPTER XIII.

ENVELOPES OR COVERINGS OF SOLIDS.*

BOILERS, pipes, tanks, and vessels of different kinds are usually made of sheets or plates of metal which are fastened together so as to form structures of various geometrical forms. In designing them it is essential to lay off the plates so that they would cover solids of the form of the inside of the structure composed of the plates. Some of the most ordinary problems of this kind which a draftsman is called upon to solve will therefore be elucidated.

PROBLEM 117. *To lay off the envelope of a cylinder.*

Let *a b c d*, fig. 313, represent a side view cylinder 8 in. in diameter and 10 in. long. The

Fig. 311.

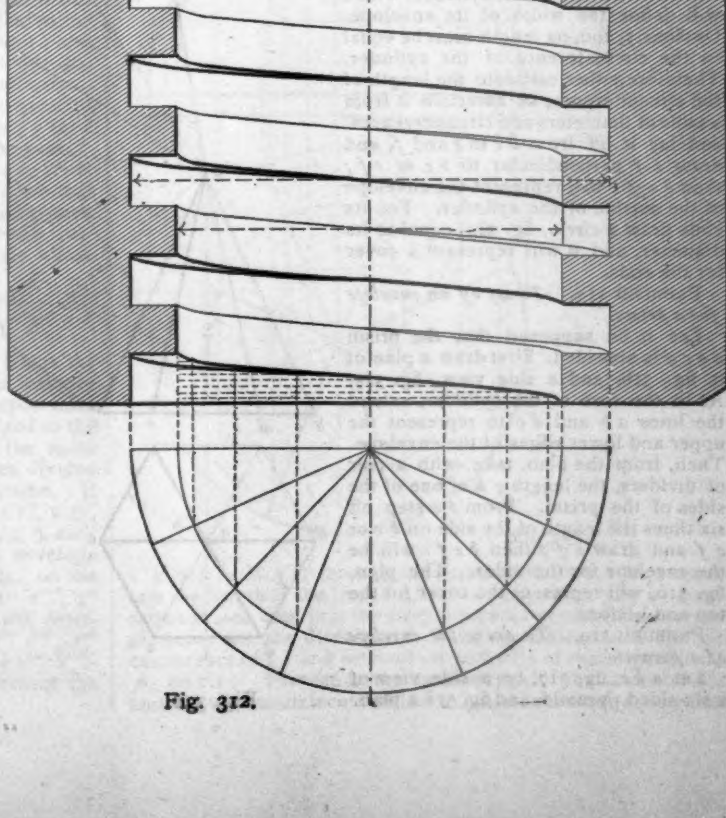
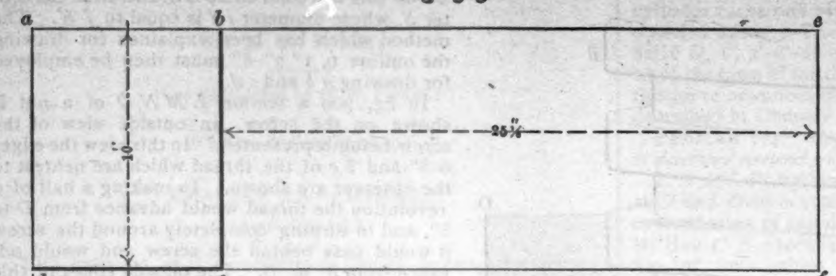


Fig. 312.

* Draw the figures in this chapter double the linear scale to which they are engraved.

Fig. 313.



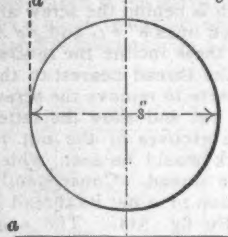


Fig. 314.

Fig. 315.

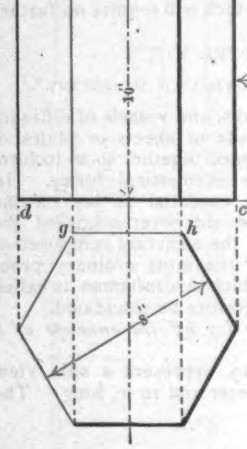


Fig. 316.

width of an envelope to cover the outside of the cylinder must obviously be equal to its height. Therefore extend the lines *a b* and *d c*, representing the top and bottom of the cylinder, which will define the width of its envelope. Obviously, too, its length must be equal to the circumference of the cylinder. Therefore either calculate the length of the circumference, or ascertain it from a table of diameters and circumferences, and lay it off from *b c* to *e* and *f*, and draw *e f* perpendicular to *b e* or *c f*; then *b e f c* will represent the envelope of the outside of the cylinder. For its ends draw a circle, fig. 314, equal to its diameter, and it will represent a cover for the ends.

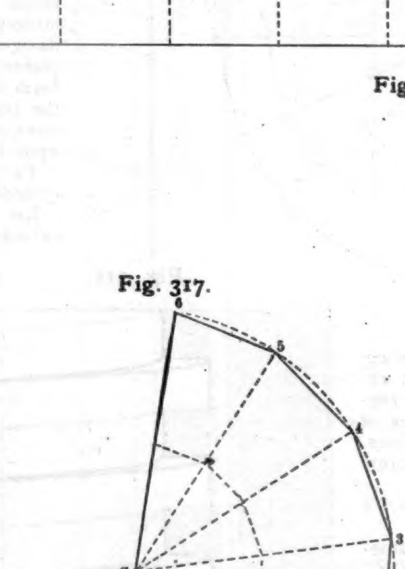
PROBLEM 118. *To lay off an envelope for a prism.*

Let it be supposed that the prism *a b c d* is six-sided. First draw a plan of it, fig. 316, and a side view, fig. 315. As in the case of the cylinder, extend the lines *a b* and *d c* to represent the upper and lower edges of the envelope. Then, from the plan, take, with a pair of dividers, the length *g h* of one of the sides of the prism. From *b c* step off six times the length of the side on *b e* or *c f* and draw *e f*; then *b e f c* will be the envelope for the sides. The plan, fig. 316, will represent the cover for the top and bottom.

PROBLEM 119. *To draw the envelope of a pyramid.*

Let *a b c*, fig. 317, be a side view of a six-sided pyramid, and fig. 318 a plan.

Fig. 317.



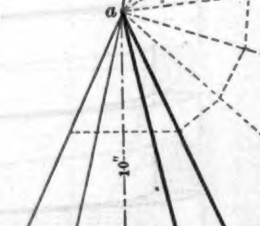


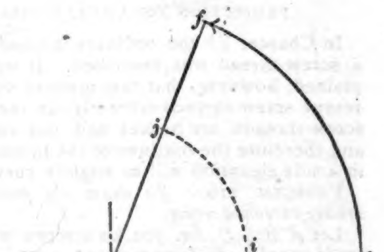
Fig. 318.

It is obvious that the cover of any one side, as *a c e*, represented by *a' c' e'* in the plan, is bounded or enclosed by the edges *a c*, *a e*, and *e c*. Consequently if the line *a c* is supposed to represent one side of the envelope if we take *a c* as a radius and describe an arc at 1, and with *e' c'* as a radius and *e* as a center, we intersect the first arc at 1 and draw *a* 1, then the area *a c* 1 will represent the cover for the side *a e c*. Continuing in the same way, if we describe intersecting arcs at 2 with the same radii and *a* and 1 as centers, we will have the area *a* 1 2, which will be the cover for the side *a d e*. In the same way the whole area *a c* 1 2 3 4 5 6 may be completed, which will be the envelope of the sides of the pyramid. A continuous arc *c* 1 2 3 4 5 6 may be drawn, and the length *e' c'* or *d' e'* of one side of the base can then be set off six times from *a* on this arc, and if straight lines *c* 1, 1 2, 2 3, etc., are drawn through these points and drawing *b a* the envelope will be completed. The cover for the base will be the hexagon shown in the plan.

PROBLEM 120. *To draw the envelope of a cone and of a frustrum of a cone.*

If *a b c*, fig. 319, is a side view, and fig. 320 a plan of the cone, then any line, as *c' a'* or *d' a'*, drawn from the circumference of the base to the vertex *a* on the cone itself will be equal to *a b* or *a c*. Consequently if with *a* as a center and *a c* as a radius, we describe an arc *c e f*, and if we make this arc equal in length to the circumference of the base and

Fig. 319.



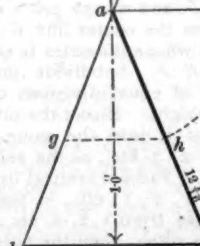


Fig. 320.

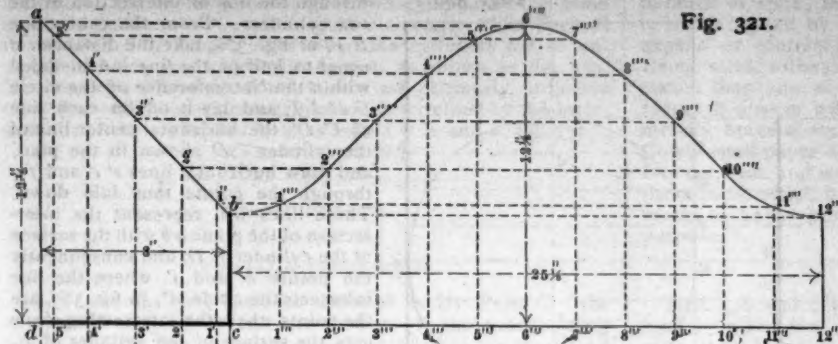


Fig. 321.

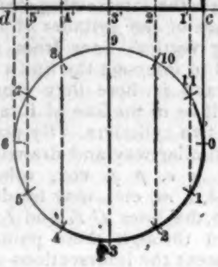


Fig. 322.

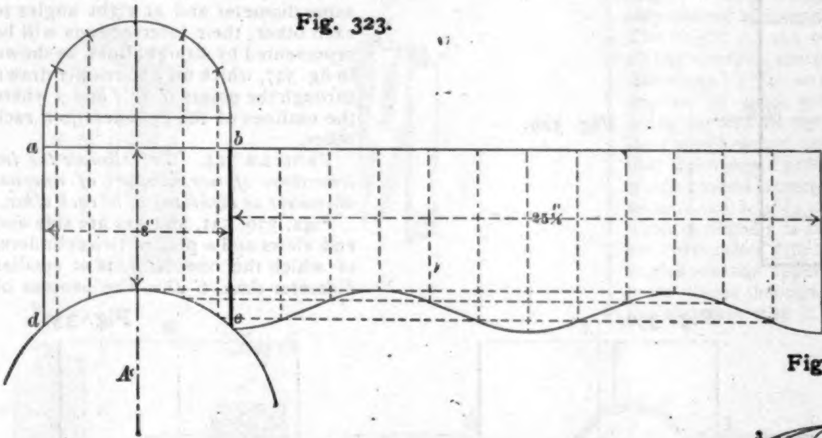


Fig. 323.

draw $f\ a$, then $c\ e\ f\ a$ will form an envelope for all of the cone excepting its base. The distance $c\ e\ f$ may be laid off approximately by taking a distance equal to 1 in. in a pair of dividers and then stepping off from c on $c\ e\ f\ a$ number of inches equal to the circumference of the base; or get the length of the side $a\ c$ and the circumference of which it is the radius. Then divide 360—the number of degrees in a circle—by this circumference, and multiply by the circumference of the base. The quotient will be the angle $c\ a\ f$. Lay off this angle and draw $a\ f$; then $f\ e\ c$ will be equal in length to the circumference of the base.

To lay off the envelope for a frustrum of a cone $h\ c\ b\ g$, first draw the envelope for the whole cone $a\ b\ c$. Then draw that $a\ h\ i\ j$ for the small cone $a\ g\ h$. Then the difference between $a\ c\ e\ f$ and $a\ h\ i\ j$ or $h\ c\ e\ f\ j\ i$ will be the envelope of the frustrum. The covers for the base and top will be circles whose diameters are equal to $b\ c$ and $g\ h$.

PROBLEM 121. *To find the envelope for a cylinder a b c d, fig. 321, having one of the ends a b cut off at an angle to its sides a d and b c.*

Draw a plan, fig. 322, below the side elevation, and divide the circumference into any number of equal parts—in this instance twelve—and through these points draw vertical projection lines to $a\ b$. Extend the base $d\ c$ to 12''', and make c–12''' equal to the circumference of the cylinder. Divide c–12''' into the same number of equal parts that the circumference has been divided into, and draw vertical lines through the points of division. It will be seen that the intersection of the vertical lines 1 1'', 2 2'', 3 3'', etc., with $a\ b$ are the projections of the points 1, 2, 3, etc., on $a\ b$. Now the lines 1''' 1'''', 2''' 2'''', etc., on the envelope correspond with the vertical lines 1' 1'', 2' 2'', 3' 3'', etc., on the cylinder. Therefore, by drawing horizontal lines 1'' 1'''', 2'' 2'''', etc., the points of intersection 1'''' 2'''' 3'''', etc., will determine the length of the vertical lines or ordinates 1''' 1'''', 2''' 2'''', etc., on the envelope, and by drawing a curve b 1'''' 2''''–12'''' through the extremities of those lines it will represent the form of the envelope.

PROBLEM 122. *To draw the envelope for a cylinder which penetrates another cylinder.*

Let $a\ b\ c\ d$, fig. 323, represent a cylinder which is attached to or penetrates another cylinder A. Draw a plan or half plan of the cylinder $a\ b\ c\ d$ above it, and proceed as in Problem 121. The engraving makes the process sufficiently obvious.

PROBLEM 123. *To draw the envelope for a hemispherical dome c a b, fig. 324, divided into eight equal sections, the joints being in vertical planes.*

First draw a plan, fig. 325, of the dome below fig. 324 and divide its circumference into eight equal parts. Ascertain the circumference of the base, and take one-eighth of it and lay it off at $d\ e$ on $c\ b$ extended. Bisect $d\ e$, and erect a perpendicular $f\ g$ through the point of division. The arc $b\ a\ c$ being a semicircle of a diameter $c\ b$, the arc $a\ b$ is equal to one-quarter the circumference, of which $c\ b$ is the diameter. It will be observed that sections extend from $b\ c$ to the vertex at a. Consequently the length of the sections is equal to the arcs $a\ b$ or $a\ c$, which as explained are equal to one-quarter the circumference of the base of the dome. Set off this distance $g\ f$ on the perpendicular in fig. 326 and it will represent the height of the section. Divide each of the arcs $a\ b$ and $a\ c$ into the same number of equal parts c 1, 1 2, 2 3, and 3 a—four in this case—and draw horizontal lines 1 1, 2 2, and 3 3 through the points of division. Divide the perpendicular $f\ g$ into the same number of equal parts that $c\ a$ and $b\ a$ have been divided into, and draw horizontal lines

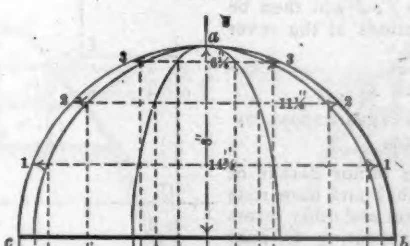


Fig. 324.

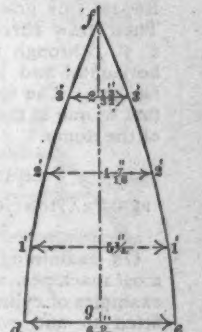


Fig. 326.

Fig. 325.

1' 1', 2' 2', and 3' 3' through the points of division. Now ascertain the length of the lines 1 1, 2 2, and 3 3, of fig. 324, by measurement, and ascertain the circumferences of which these measurements are the diameters. Take one-sixteenth of the circumference of 1 1 and set it off on each side of the perpendicular $f\ g$ on 1' 1'. Proceed in the same way with the diameter 2 2, and set off one-sixteenth of its circumference from $f\ g$ on 2' 2'.

Fig. 327.

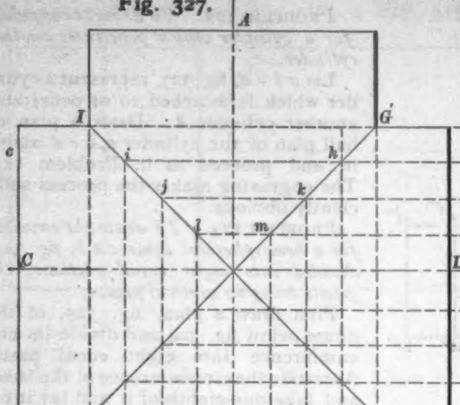
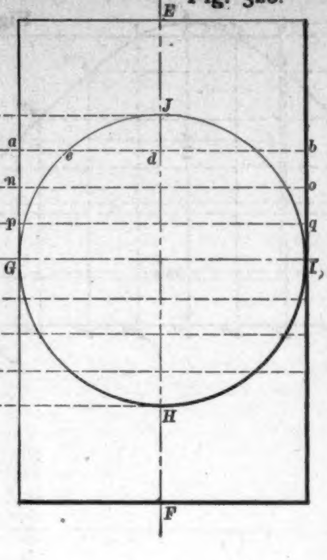


Fig. 328.



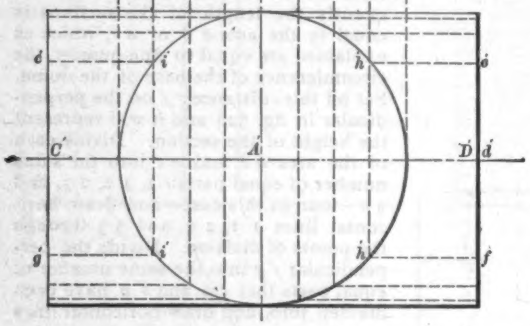


Fig. 329.

Repeat this process with 3 3 and 3′ 3′. Then draw curves *d* 1′ 2′ 3′ *f* and *e* 1 2′ 3′ *f* through the extremities of the horizontal and perpendicular lines in fig. 326. The figure *f e d* will then be that of one of the sections of the cover of the dome.*

CHAPTER XIV.

PENETRATIONS OR INTERSECTIONS OF SOLIDS.

ON examining the minor details of most machines, we shall find numerous examples of cylindrical and other forms fitted to and even appearing to pass through each other in a great variety of ways. A number of examples have therefore been selected, showing the outlines formed by the penetration of various solid bodies, with a view of exhibiting those cases which are of most frequent occurrence, and elucidating the general principles which are applicable in every case.

PENETRATIONS OF CYLINDERS.

PROBLEM 123. *To delineate the intersections of two cylinders of equal diameters at right angles to each other.*

Let fig. 327 represent a side view, fig. 328 an end view, and fig. 329 a plan of two such intersecting cylinders *A B* and *C D*. Suppose *a b*, fig. 328, to be a plane cutting the one cylinder, *C D*, parallel, and the other, *A B*, at right angles to its axis. Extend this plane to *c*; then obviously it will pass through the line of intersection of the two cylinders. From the center line *E F*, of fig. 328, take the distance *e d* equal to half of the line *a b* included within the circumference of the circle *G H I J*, and lay it off on each side of *C D′*, the horizontal center line of the cylinder *C D* shown in the plan, and draw horizontal lines *e′ c′* and *f g* through the points thus laid down. These lines will represent the intersection of the plane *a b* with the surface of the cylinder *C D*, and consequently the points *h′* and *i′* where the line intersects the circle *A′*, in fig. 329, are the points where the intersecting plane cuts the surface of the cylinder *A B*. By projecting vertical lines from *h′* and *i′* upward to intersect the line *a c*, the points *h* and *i* where they cross each other will be in the line of intersection of the two cylinders. By proceeding in a similar way and drawing other planes, *n o*, *p q*, etc., other points, as *j*, *k*, *l*, *m*, etc., may be determined, and the lines *G E* and *I J* may be drawn through these points and will represent the intersections of the two cylinders. If they are of the same diameter and at right angles to each other, their intersections will be represented by straight lines, as shown in fig. 327, which may be readily drawn through the points *G*, *E*, *I* and *J* where the outlines of the cylinders join each other.

PROBLEM 124. *To delineate the intersections of two cylinders of unequal diameters at right angles to each other.*

Figs. 330, 331, and 332 are side and end views and a plan of two cylinders, of which the one, *A B*, is of smaller diameter than *C D*. The process of

Fig. 330.

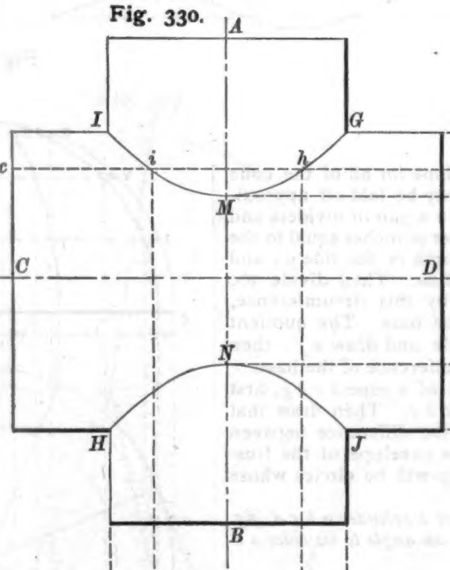
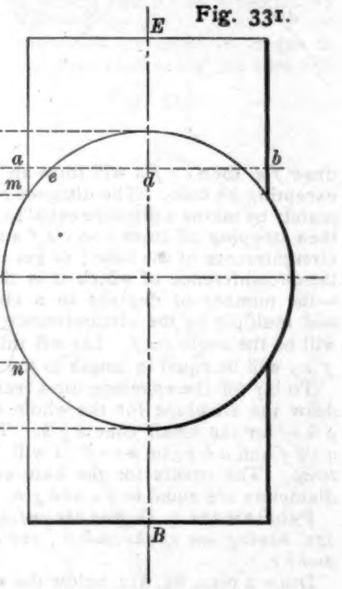


Fig. 331.



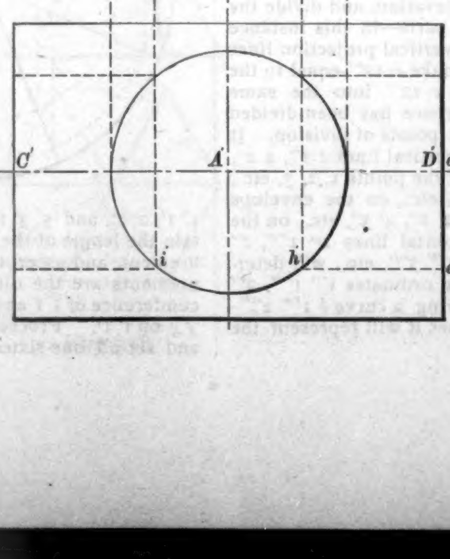


Fig. 332.

* The student will find that constructing the projection of the junction lines in the covering of the dome, as shown in fig. 324, is an interesting problem. He should be able to work out the method of doing it from the drawing without further explanation.

delineating the intersections of these two cylinders is the same as that described for those of equal diameters. The lines of intersection $G\ M\ I$ and $J\ N\ H$ when the cylinders are of unequal diameter are hyperbolic curves, as shown in fig. 330. The vertices M and N of the curves are obviously projected directly; and their extreme points are determined by the intersections of the outlines of both cylinders at m and n, fig. 331.

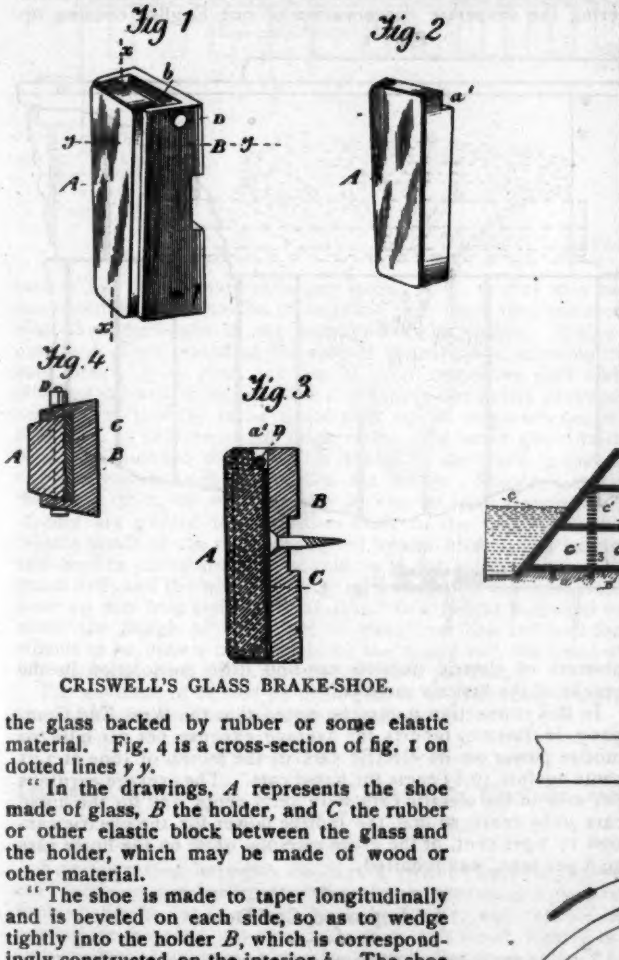
(TO BE CONTINUED.)

Recent Patents.

CRISWELL'S BRAKE-SHOE.

A GLASS brake-shoe has been patented by Mr. Peter C. Criswell, of Wheeling, W. Va., the number of the patent being 455,033. This device can best be described in the inventor's own words, as follows: "The special object of this invention is to make brake-shoes so that they will not wear so rapidly as those which have been heretofore used. For this purpose I have experimented and have discovered that a shoe made of glass or faced therewith will greatly outwear those made of any material hitherto used for the purpose.

Fig. 1 of the drawings represents my invention in its holder in perspective; fig. 2, a detail view of a preferred form of shoe; and fig. 3, a section on dotted line $x\ x$ of fig. 1, showing



CRISWELL'S GLASS BRAKE-SHOE.

the glass backed by rubber or some elastic material. Fig. 4 is a cross-section of fig. 1 on dotted lines $y\ y$.

"In the drawings, A represents the shoe made of glass, B the holder, and C the rubber or other elastic block between the glass and the holder, which may be made of wood or other material.

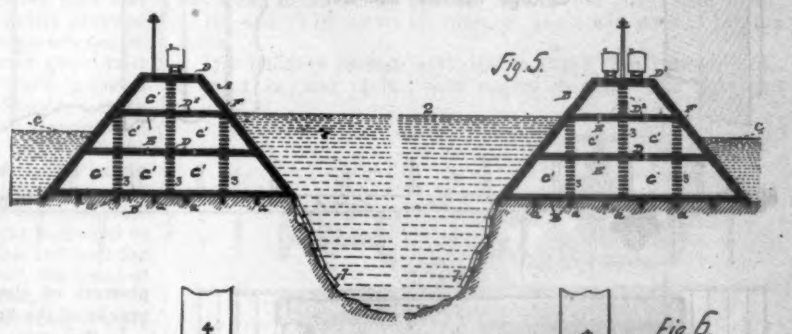
"The shoe is made to taper longitudinally and is beveled on each side, so as to wedge tightly into the holder B, which is correspondingly constructed on the interior b. The shoe A is also notched at a', and across through this notch and the sides of the holder B passes the screw-bolt D, on which fits a suitable nut to hold the bolt securely in position. The shoe A is thus held in a tightly wedged condition all the time.

"The advantages of glass as a material for brake-shoes are that it is much more durable than those which have been heretofore made of wood, metal, asbestos, or compressed paper, as it is not abraded and worn off by friction like other known materials for the purpose; secondly, being moulded to any form or size, it is cheap and easily made to fit any required or preferred holder; thirdly, having no pores or grain, it is not liable to crack or split; fourthly, being a non-combustible substance, it is not injured by the frictional heat, and, fifthly, it does not expand or contract under the influence of heat or moisture. Being solid, without grain, and not porous, it is a harder substance than any of those heretofore used for brake-shoes. Hence it always wears smooth without heating or cutting like metallic brake-shoes, while it will outwear three wooden shoes. Compressed paper and asbestos are soft like wood, and therefore cut, heat, and wear out much more quickly. In view of all these facts, which have been corroborated by practical tests, it seems to be the best substance which can be employed for the purpose."

KIRK'S RIVER JETTIES.

Figs. 5, 6 and 7 show an improvement in river jetties covered by patent No. 455,216, issued to Arthur Kirk, of Sharpsville, Pa. Fig. 5 is a cross section of a stream with such jetties; fig. 6 is a plan illustrating one of the details described below; fig. 7 is a plan showing the arrangement of the jetties on one side of the river, those on the opposite side corresponding exactly.

In figs. 5 and 7 are shown the course of a stream, 2; A and B are side walls or jetties, which are separated from each other a sufficient space to provide a proper channel between them, and at their upper ends are flared outwardly, so as to catch the water and converge it within the channel. A series of wing dams or walls c project from the outer sides of the jetties A and B toward the shores and slant upstream, say, at about an angle of 45°. These wings on a given side of the jetties are preferably placed at intervals about half or a quarter of a mile apart. The height of the walls A and B is sufficient to collect nearly all the water of the stream during low water, and in high water the wings $c\ c$ will so shoal and retard the flood water that it will deposit its sand, gravel or alluvium behind the wings, and in doing so will fill up the bottom and in time will recover much land which would otherwise be of little value. It will be noticed that the wings c project from the sides of the jetty-walls $A\ B$, which extend upstream from their juncture with the wings, so as to make angles c'', which check the current and cause the water to deposit its alluvium. In this point this invention is different from other prior systems, in which, instead of having closed angles on the upper sides of the wings, there are openings at these places through which the water may flow freely, carrying the alluvium with it. As shown in fig. 5, the wings c are made



KIRK'S ARRANGEMENT OF RIVER JETTIES.

to increase gradually in height at an angle of about 30° or more from the jetty-wall to the shore. The purpose of this is that when the stage of water is high in the river the flow over the jetty-wings and the swiftest current may be toward the middle of the stream at the junction of the wing with the jetty-wall,

while near shore the water, being backed up by the wing, may be slack. This prevents the useless formation of sand-banks in the middle of the stream, and renders the reclaiming of the land much more certain and efficacious.

The construction of the jetty walls is shown in fig. 5. The walls are composed of planks or sawed timber, the bottom floor *B'* resting on mud-sills *a a a*, and the timber frame is built up so as to form chambers *c' c'*, which are filled with sand or other suitable material through holes *E*, made in the flooring *D*. These chambers are built up one over the other until the desired height is reached. It is best to fasten the timbers with wooden pins. A road or railroad may be carried along the top.

To prevent scouring under the wooden walls the banks may be protected by chains 7, in fig. 5. composed of wooden links, which are hung from the bases of the jetty-walls and lie upon the bed of the channel. The links are weighted, so that they may sink to the bottom of the stream. These links are shown in fig. 7 in plan.

Manufactures.

A New Copying Process.

A NEW copying process, by which drawings can be copied in their original colors on a white ground, is being introduced by F. W. Devoe & Company, of New York. The special merit of this process is that sectional and other colors can be reproduced exactly, which is sometimes a very convenient matter. The drawing has to be made in special ink, and the copies cost little more than an ordinary blue print.

The City & South London Electric Road.

THE *Electrical World* of recent date says: "Our cable dispatch this week gives the net results of the first half year's operation of this unique road. It is promising, although not altogether satisfactory. The net profits have been a little over $20,000, an amount only sufficient to pay the interest on the bonds. The total operating expenses per train mile were about 53 cents, which strikes one as being decidedly high; it is certainly high compared with the expectations of the promoters. It will be decidedly interesting to learn whether Mather & Platt, the constructors, are safe in their guarantee of a maximum cost of seven cents per train mile for motive power. Comparisons with American enterprises might be made, but would not be especially instructive on account of totally different conditions. The City & South London Road, as the only underground electric system, is a useful example for the contemplation of those who propose engaging in similar enterprises elsewhere; taken altogether its operation has been very satisfactory, there have been some slight difficulties, but the failures have, as a rule, not been electrical, and could not be fairly charged up to imperfections in the motor system employed. Concerning ventilation, a question that has been much mooted in connection with the proposed underground system in this city, opinions seem to differ very widely. Some of those who have ridden upon the line say that it is eminently agreeable, while others aver that the atmosphere in the tunnel is nothing short of miasmatic. The cars are kept closed for the most part, and consequently are not well ventilated. How much of the allegations against the tunnel are due to the closed cars it is not easy to say. It might be added that information concerning the actual experience obtained in this half year's operation is very difficult to get hold of; for some reason, good or bad, the managers of the road are as mum as oysters as to the details of the work. Nevertheless the road may be classified as fairly successful, and, considering the desperate conservatism of our English cousins, opponents of electric traction can find little consolation in the results of the first six months."

In this connection it may be noted that the West End Company, in Boston, reports the average expense per car mile for motive power on its electric cars in the month of June at 7.31 cents against 10.83 cents for horse cars. The average earnings per mile of the electric cars were 42.71 cents, and for the horse cars 36.85 cents, so that the motive power for the electric cars cost 17.1 per cent. of the gross receipts, while on the horse cars 29.8 per cent. was required.

An Improved Car Door.

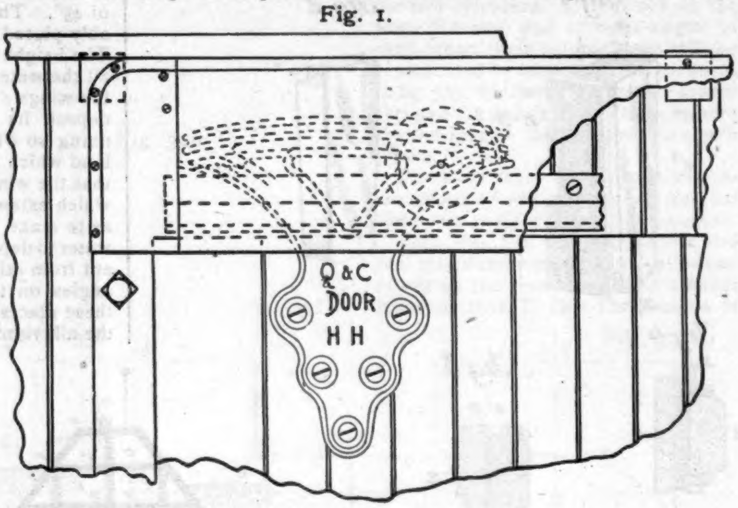
THE accompanying illustrations show a door which, it is claimed, answers the requirements that a freight-car door must be strong, spark-proof, of simple construction, and few parts.

The best malleable iron is used for hangers, wheels, stops, etc., and steel track, made of one piece for any width of door, applied so that no screws or nails can possibly come in contact with the running parts of the door. A complete housing cap is made of metal, with malleabe iron ends riveted together and ready for application.

A new feature is the supply by this company of malleable iron guides and wedges for bottom of door, which, by their construction, offer also a thorough lock when the door is either open or shut, saving all damage by door slatting. Fig. 1 is a side view of the top of this door; fig. 2 a section; fig. 3 shows the bottom rail; fig. 4 is a general view of the door.

Fig. 2.

Fig. 1.



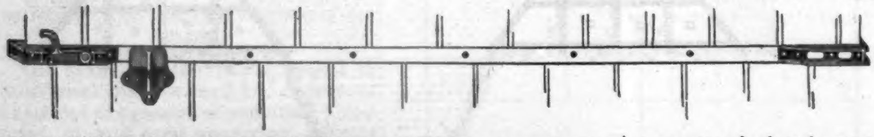
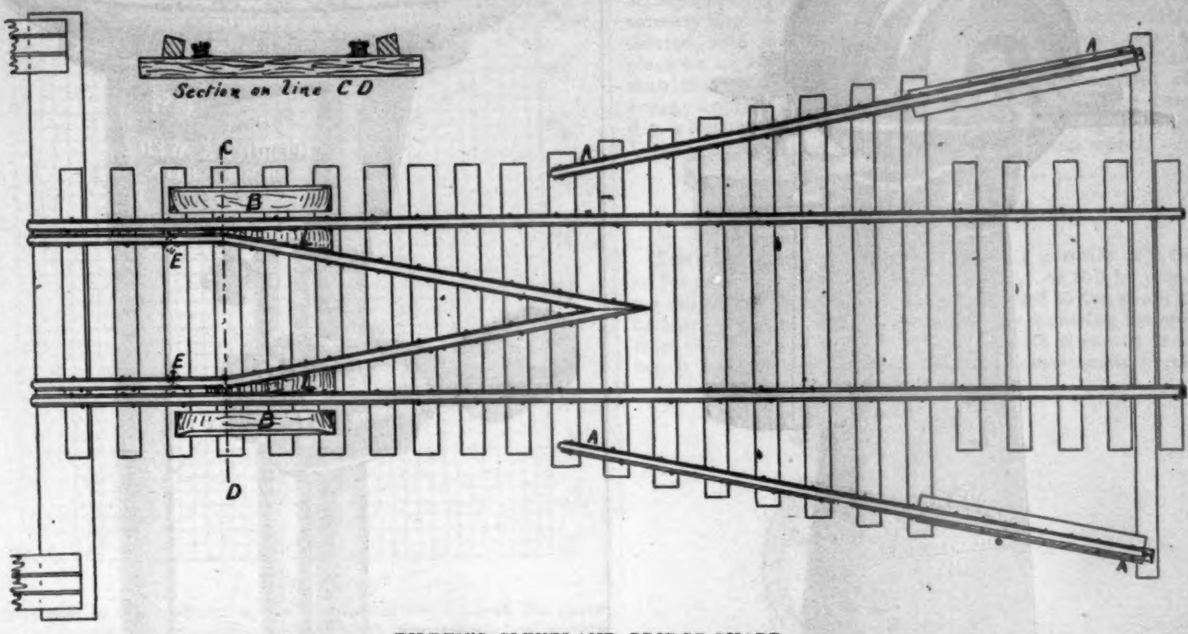


Fig. 3.

Fig. 4.

The Tilden Bridge-Guard.

THE accompanying sketch shows the bridge-guard made by B. E. Tilden & Company, of Cleveland, O., which has been brought into use on a number of lines. The sketch shows a general plan and a cross-section on the line *C D*. The plan is for a single-track bridge with the inner and outer T guard-



TILDEN'S CLEVELAND BRIDGE-GUARD.

rails. The inner guard-rails may end at *E E*, or they may be continued adjacent to the main track rails until they connect with the guard-rails at the other end of the bridge. Bridge-guards *B B* are placed at the side of the rails and opposite to each other, 3 in. from the top of their respective rails and pitching toward them. Lifters *L L* fit into the cavity between the rails, so that the inner guard-rails cannot approach nearer than 2 in. to the top of the track rails. The outer guard-rails *A A* are intended to direct the wheels to the track in case a car is derailed as it approaches the bridge. Should a truck leave the track, its wheels come in contact with a guard-rail, *A*, and are guided to a position close to the rails where the wheels inside of the track are raised by the lifter *L* to a height sufficient to crowd tread of wheels on to the track by adjacent guard-rail, and the wheels outside of the track at the same time pass up the frog and are thus lifted to a height sufficient to allow the flange of the wheel to pass over the rail and the wheels to be drawn on the rails by the guard-rail, the tread of wheels running on the replacers instead of the flange.

The advantages offered by these guards in protecting bridges can readily be seen by examining the sketch.

Improved Automatic Square Chisel Car Mortiser and Borer.

THE engraving herewith displays a recent improved heavy car mortising and boring machine of the type using square or hollow chisels. It is especially designed for, and capable of cutting the heaviest mortises in hard or soft wood, from $\frac{1}{8}$ in. to 9 in. deep, leaving each mortise entirely free from chips. It will also make end tenons, gain or mortise clear through a 9-in. timber, also countersink for bolt heads. Its high efficiency and adaptability to the work for which it is intended and the great variety of work which can be accomplished with it at one handling of the timber makes it a time and labor-saving machine.

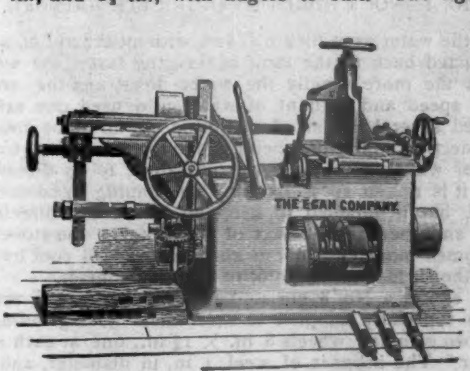
The column is one entire casting cored out at the center, strongly braced and thoroughly able to withstand any strain or shock that may be given it. All working parts are planed perfectly true and in line with each other.

The bed rests on the main column, held in position by gibs, the cross movement being controlled by a friction clutch provided with stops to gauge the length of mortise. The upper part of the bed which holds the timber has an extra movement operated by a hand-wheel and screw to gauge the depth of mortise. All other makes of this style of machine have a stationary bed, and the depth of mortise is made by blocking up behind the timber that is being mortised.

The chisel mandrel is driven by new improved friction gearing, with a quick return, and raised and lowered by rack and pinion. There are suitable stops provided for gauging the travel of the slide, also a regulating screw for changing the position of the chisel to suit the work. The machine will take in stock up to 16 in. wide and 14 in. deep, and cut a gain at the top of a 12-in. timber.

If necessary, an extra boring attachment can be fitted to the machine for boring joint-bolt holes, side sills and general work, and when so made, the builders furnish one auger each $\frac{9}{16}$ in., $\frac{11}{16}$ in., and $1\frac{3}{16}$ in. by 10 in. twist, or any other sizes to suit the work.

The builders furnish with the machine four chisels, $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in., and $1\frac{1}{4}$ in., with augers to suit. The tight and



IMPROVED CAR MORTISER AND BORER.

loose pulleys are 12 in. × $6\frac{1}{2}$ in., and should make 650 revolutions per minute.

For further information in regard to this, address the builders, The Egan Company, Nos. 194–214 West Front Street, Cincinnati, O.

Wing's Centrifugal Grinding Machines.

THESE machines, some examples of which are illustrated herewith, represent a radical departure in the construction of grinders for tempered tools. The difficulty with such grinders has been that it has been necessary to run them at low speed, or else to use water to keep them from drawing the temper; and no method tried for applying the water has been altogether successful. In the centrifugal grinders the water is applied to

the stone or wheel at a point near its center, and by capillary attraction is caused to stick to the surface and accumulate in quantity until overcome by centrifugal force imparted by the wheel, then commencing to flow in the direction of the point of its largest diameter, which is entirely encircled by a case which

FIG. 1.—NO. 8 HORIZONTAL DOUBLE GRINDER.

catches the water as it flies off, and without the aid of a pump is conducted back to the tank again; the faster the wheel is revolved the more rapidly the water flows, and the ordinary rates of speed and amount of water now used can safely be multiplied several times. And this is not all to be noticed in this connection; the water being made to flow on and over the surface of wheel with force, at right angle to its direction of motion, it is not so apt to fly off when coming in contact with the tool, but is inclined to keep on its natural direction of course; and then the current of water keeps the stone clean and becomes more effectual in keeping the tool cool by being held on the surface at the point of grinding contact.

Fig. 1 shows a No. 8 horizontal double grinder, a machine which is especially adapted to machinists' tool grinding. It carries two grinding wheels 8 in. × $1\frac{3}{4}$ in., one at each end of the arbor. The arbor is of steel, 1 in. in diameter, and runs in removable bronze bushings, which can be easily replaced when worn; these are self-oiling. The water is carried to the wheels from the tank by head force and back into the tank by centrifugal force, keeping up a continuous circulation as long as there is water enough kept in the tank to cover the supply-pipes. This size is also made up to carry a single wheel, and fitted with short legs for bench use, or stand for floor, as preferred, the price being considerably less than for the double-end machine. Larger machines bearing the above description are in preparation and nearly completed.

Fig. 2 shows a No. 12 upright grinder; this machine carries a single wheel, 12 in. in diameter by 2 in. thick, and is mounted on a steel arbor $1\frac{1}{4}$ in. in diameter, running in removable bronze bushings. The grinding face of the wheel is slightly bevelled to accommodate the grinding of long knives which have to lay across the wheel from one side to the other. It is designed for grinding all kinds of wood-working tools having straight edges, like planes, chisels, knives, etc., and is also effective for grinding machinists' and kindred tools, but might be considered by some not quite so convenient as the horizontal machines. The water is brought on to and carried over the surface of wheel and back to tank again by centrifugal force alone, and so continuously as long as water is kept in tank. This machine is as simple in its construction in every respect as the plainest grindstone frame, supplies itself with an abun-

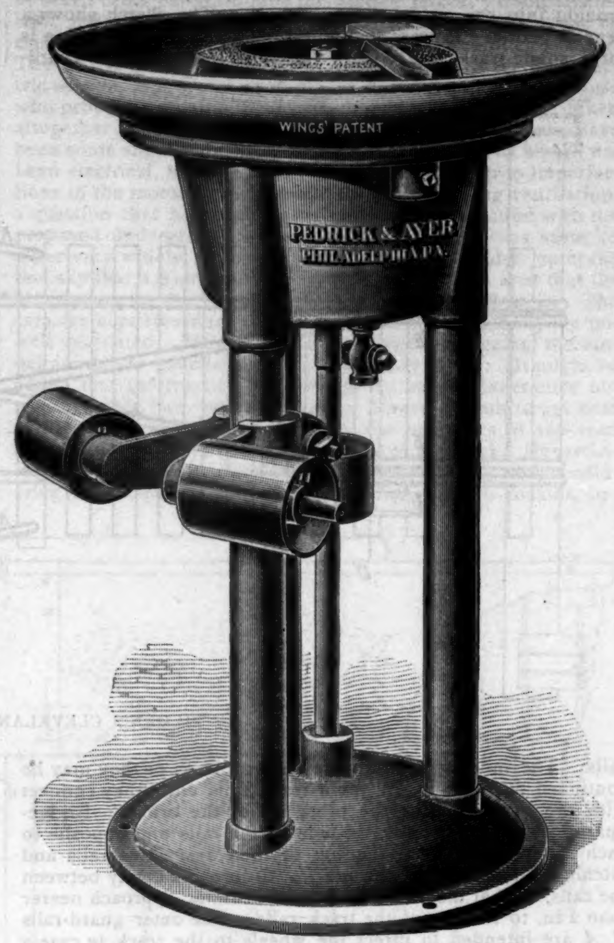


FIG. 2.—NO. 12 UPRIGHT GRINDER.

dant amount of water, is much neater and will do much better and more work.

These machines are made by the well-known firm of Pedrick & Ayer in Philadelphia.

Electric Lighting by Water Power.

(Condensed from a paper read by Mr. C. T. Ryland, Jr., before the California Electrical Society.)

AFTER giving a short history of electric lighting by water power on the Pacific Coast, Mr. Ryland proceeded to explain some experiments which he had recently made, suggested and made necessary by the fact that so far none of the different manufacturers of water-wheels had succeeded in producing a

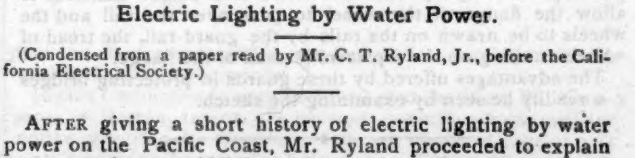


Fig. 1.

water-wheel governor sufficiently sensitive and reliable for electrical purposes, especially for incandescent lighting.

Mr. Ryland conceived the idea of dispensing with the governor entirely, and controlling the potential by over compound-

ing the dynamo; requiring a greater speed of the dynamo to maintain the voltage as lights were turned off. In order to construct the dynamos upon this principle it became necessary to obtain a curve of efficiency from some one of the well-known water-wheels in use. The Dodd sigmoidal water-wheel was selected as the best and most efficient for this purpose.

An 18-in. diameter wheel was employed, which is illustrated

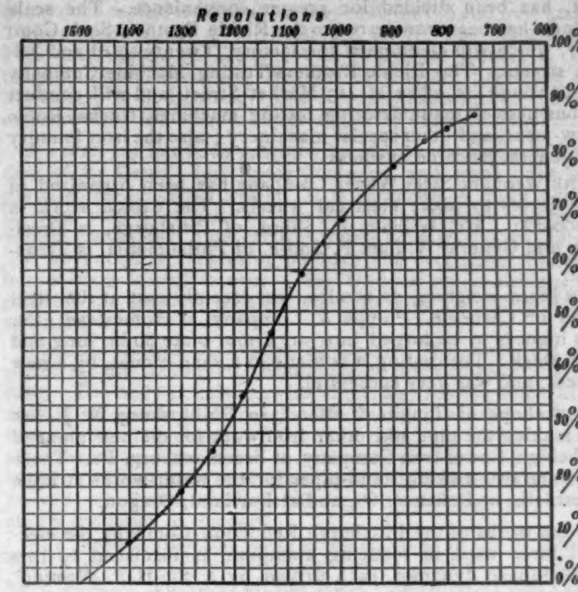


Fig. 2.

herewith in fig. 1, under a head or fall of 213 ft., and the curve of efficiency—fig. 2—was obtained by running the wheel empty and gradually increasing the load from time to time until the maximum was reached.

This curve being obtained and mapped out, the proper number of additional series turns were wound upon the fields of the dynamo, with the following result: At full load the proper voltage was maintained at 750 revolutions per minute of the armature, and when only one lamp was burning the speed was 1,060 revolutions. The effect was that, as the lights were turned off, the wheel ran faster and diminished in power, yet the voltage remained practically constant.

The dynamo used was the Wenstrom, which seemed peculiarly adapted for this kind of work for two reasons: 1. The normal speed is about half that of other dynamos of the same

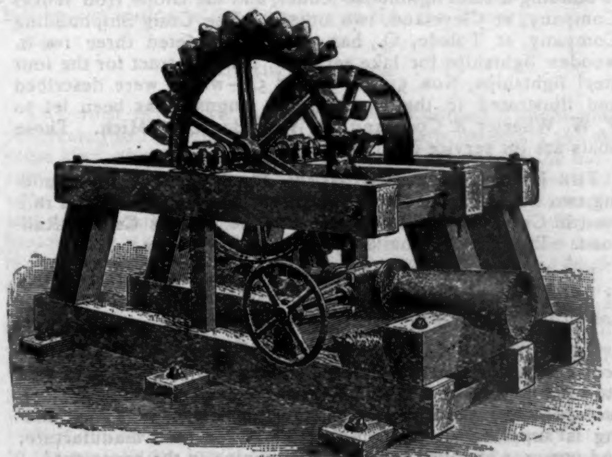


Fig. 3.

capacity. 2. The wires of the armature are threaded through the iron disks, making a practically iron-clad armature; it being impossible for any wires to work loose at any speed of the machine.

Mr. Ryland then described the place where the dynamo was placed, being situated near the bottom of a deep ravine about 300 ft. from the hotel. The water is turned on at 6 o'clock in the evening and turned off at 1 o'clock, without any further attention, and yet lights in the different rooms can be turned on or off without any perceptible change in the brightness of the remaining lights.

The water-wheel employed is perhaps the most recent invention in its class, and possesses points of superiority over other wheels that perhaps may be of interest.

Tangential wheels depend for their high efficiency not only upon the impact of the stream applied, but upon the reactionary effect of the water discharging from the buckets or vanes. None of the wheels heretofore have taken into consideration the effect of centrifugal force (generated under high velocities) acting upon the water when received into the buckets. In the construction of the Dodd wheel this force had been duly considered, with the result that the discharge of the water takes place on each side of the wheel at a point of greater diameter than that of impact, thus utilizing a greater amount of the energy applied than any wheel in its class that we know of. Fig. 3 illustrates the difference in lines of discharge between the Dodd wheel and that of the ordinary tangential wheel.

A Portable Railroad Drill.

THE illustrations given herewith show a portable drill intended for drilling rails and similar purposes. As will be seen from the engraving, it can also be readily adapted to the use of bridge builders and structural iron workers. By removing the machine from the base and bolting it to the bench it can be used as a bench drill in the shop. In building cable roads or electric

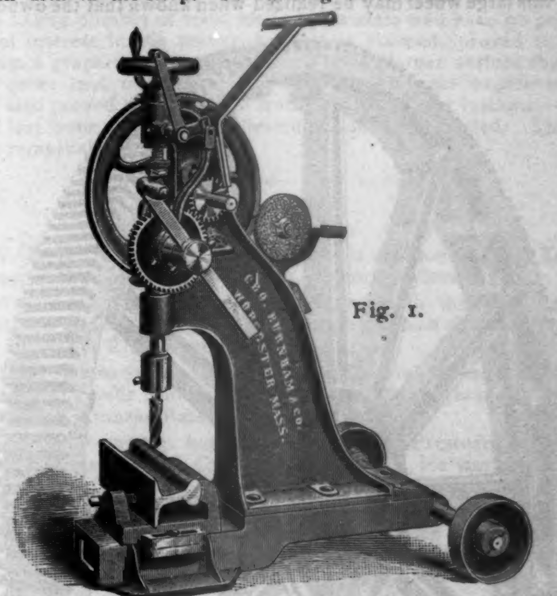


Fig. 1.

PORTABLE RAILROAD DRILL.

roads it is a very useful tool. The makers claim that it will do the work of a ratchet drill in much less time, while it can be more readily applied to the work. The special chuck holding the rail can readily be removed and an ordinary chuck put on in its place.

The machine is provided with an emery wheel for grinding up the drills used—a very useful feature where it has to be used

Fig. 2.

at a distance from the shop. This grinding wheel is geared to make 17 revolutions to one of the crank, and can be brought into use by turning a thumb-screw which brings a friction-wheel in contact with the fly wheel.

The crank is on the same shaft with the balance-wheel, and there is a handle on the balance-wheel, so that two men can work at once. The feed is automatic, with five changes. The machine shown will drill holes up to $1\frac{1}{4}$ in. in diameter and 4 in. deep. As usually made the drill socket takes a $\frac{5}{8}$-in.

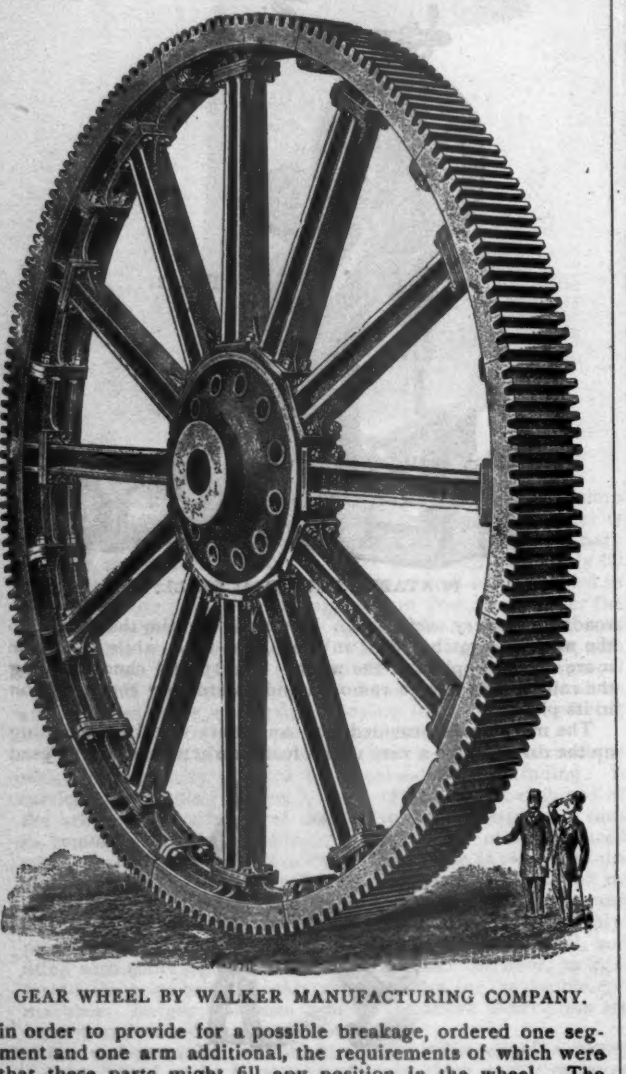
straight-shank drill, but other sizes can be furnished, or the socket can be removed and a universal chuck substituted. The machine is strongly made, and will stand heavy work; it weighs complete about 200 lbs., and the base is provided with wheels, as shown, so that it can be easily moved by the operator. Fig. 1 shows the machine with a rail in position ready to drill; fig. 2 shows how it can be handled to drill work in an inclined position. These machines are made by George Burnham & Company, at Worcester, Mass., who are well known as makers of light drills and other small tools.

A Large Gear Wheel.

THE accompanying cut shows a very large machine-cut spur-gear recently made by the Walker Manufacturing Company, Cleveland, O. This wheel, with a steel pinion made by the same concern, is used in some large pumping engines for removing water from a diamond mine in South Africa.

The dimensions of the wheel shown are: Number of teeth, 192; diameter to pitch-line, 30 ft. 6.66 in.; face, 30 in.; pitch of teeth, 6 in.; diameter of hub, 9 ft. 2 in.; bore, 27 in. The hub alone weighs 15 tons, and the total weight of the wheel is 66¾ tons.

Some conception of the exactness required in the formation of this large wheel may be realized when known that the owners,



GEAR WHEEL BY WALKER MANUFACTURING COMPANY.

in order to provide for a possible breakage, ordered one segment and one arm additional, the requirements of which were that these parts might fill any position in the wheel. The wheel was fitted up most carefully and was a fine piece of machinery, as may be judged from the illustration.

This gear, with the steel pinion, was the only part of the massive pumping machinery which was made in this country, the balance of work being contracted for in England. In reply to an inquiry as to why the gears had been singled out for manufacture at a different point from the rest of the machinery, the Engineer of the company replied that he thought they could rely on getting a superior class of iron in America, and he knew they could secure as perfect work.

General Notes.

THE business of the old firm of Riehle Brothers, in Philadelphia, has been divided for greater convenience. The scale business has been transferred to the Riehle Brothers Scale Company, which will continue at the factory, Twenty-third and Filbert streets. The Riehle Brothers Testing Machine Company will continue its office at 413 Market Street, and will conduct the business of manufacturing testing machines, trucks, Robie screw-jacks, and other special machinery; also the iron foundry and general machine business.

THE Wrought Steel Wheel Company has been organized in New Jersey to make steel car wheels. The capital stock is $2,000,000. Mr. William P. Shinn, of Pittsburgh, is President, and General William F. Smith, of Philadelphia, is Treasurer.

AN ingot weighing 32,000 lbs. was recently cast at the steel works of Carnegie, Phipps & Company, at Homestead, Pa. This ingot is to be forged into an armor-plate 80 in. long and 23 in. thick. The casting was made in a sand mould, by a new process, and was very successful.

THE shops of Tippitt & Wood, in Phillipsburg, N. J., are now making the pipe and other iron work for the new plant of the Lehigh Zinc & Iron Company, at Freemansburg, Pa. These shops are also making stand-pipes for the water-works at Lake Forest, Ill., at Defiance, O., and at Portland, Oregon.

IN the works of the Pittsburgh Reduction Company the electrical force used in reducing aluminum is furnished by two Westinghouse dynamos, each driven by a 200-H.P. Westinghouse compound engine, and by two smaller dynamos driven by one 125-H.P. Westinghouse standard engine.

THE Cowles Electric Smelting & Aluminum Company, Lockport, N. Y., announces that aluminum can now be furnished in ton lots at 50 cents per pound. This is considerably lower than any price yet made for this metal.

THE steamer *Corsica* left Ashtabula, O., July 10, ran to Escanaba, there loaded 2,607 tons of iron ore, and returned to Ashtabula, arriving there July 14. The total time of the round trip was 4 days, 2 hours, 50 minutes. Of this 90 hours 14 minutes were consumed in the two voyages, and 8 hours 36 minutes at Escanaba. This is claimed to be the fastest round trip ever made.

THERE is a considerable amount of lighthouse work now going on on the lakes. The Cleveland Shipbuilding Company is building a steel lighthouse tender, and the Globe Iron Works Company, at Cleveland, two others. The Craig Shipbuilding Company, at Toledo, O., has nearly completed three 100-ft. wooden lightships for lake service. The contract for the four steel lightships, Nos. 51, 52, 53 and 54—which were described and illustrated in the JOURNAL for August—has been let to F. W. Wheeler & Company, at West Bay City, Mich. These boats are for service on the Atlantic Coast.

THE Rogers Locomotive Works, Paterson, N. J., are building two switching and eight mogul freight engines for a railroad in Cuba, and 20 locomotives for the Illinois Central Railroad. They are also building six full snow-plows.

THE shops of the Delaware, Lackawanna & Western Railroad at Dover, N. J., are building 100 new box cars. These cars are all to be equipped with the Gould coupler.

THE Pratt & Whitney Company, Hartford, Conn., has recently completed a new brick building 300 × 45 ft. and two stories high, which is to be used for the manufacture of small tools, of which the Company makes a great variety. The building is supplied with a complete plant for their manufacture, and power is supplied by a 75 H.P. engine in the basement.

THE Erie Car Works, Erie, Pa., are to build 300 box cars for the Pittsburgh, Cincinnati, Chicago & St. Louis Railroad.

AT a meeting held in Pittsburgh, July 15, the stockholders of the Westinghouse Electric Company unanimously approved the plan of reorganization proposed, and elected the following new board of directors: Lemuel Bannister, A. M. Byers, George Westinghouse, Jr., Pittsburgh; August Belmont, Charles Fairchild, Marcellus Hartley, George W. Hebard, Henry B. Hyde, Brayton Ives, New York; Charles Francis Adams, Boston. By the plan of reorganization adopted $4,000,000 of 7 per cent. cumulative preferred stock is created, of which $3,000,000 has been taken at par by the reorganization syndicate to care for

the company's floating debt and provide additional capital. The assenting stockholders give up 40 per cent. of their stock, aggregating over $2,500,000, par value, for the use of the company, and are given upon the 60 per cent. of stock which they retain a 7 per cent. preference over the small amount of non-assenting stock remaining out.

THE Taylor Iron & Steel Company, a new organization with $1,000,000 capital stock, has succeeded to the old and well-known Taylor Iron Works at High Bridge, N. J. The officers are: President, Lewis H. Taylor; Vice-President, Robert E. Jennings; General Manager, William T. Taylor; Secretary and Treasurer, T. F. Budlong. The company has acquired the right to make steel and steel castings under the Hadfield patents.

A STEEL car has been patented by Mr. H. C. Hodges, President of the Detroit Lubricator Company, and plans have been prepared for its construction. It is proposed to build a car 68 ft. long, with a capacity of 120,000 lbs. of freight, and the inventor claims that this car will weigh only 40,000 lbs. empty. The advantage of increasing the load and decreasing the number of cars is well known. Mr. Hodges' car is designed to combine the greatest possible strength with simplicity of construction.

THE St. Charles Car Works, St. Charles, Mo., have just completed for the Jacksonville Southeastern line two beautiful chair cars. The body is finished wine color, and has the shield of the road in the center of the coach. The interior decoration of these cars is elegant mahogany finish, and they have a very spacious smoking-room, upholstered in embossed leather. The cars are heated by steam from the engine, and have the Scarritt latest improved twin chairs, which are covered with olive figured plush, to match the finish of the cars.

The Wabash road has lately given an order to the St. Charles Works for six elegant passenger coaches, to be 64 ft. long, to have smoking room and all the latest conveniences that can be put into a coach. They built and delivered to the Wabash last month 250 box cars.

An Opportunity for Practical Instruction.

THE evening class in Steam Engineering will open at the Young Men's Institute, No. 222 Bowery, New York, on September 30, and will be continued through the winter until April 27. This class is under the charge of Mr. William H. Weightman, who has conducted it very successfully in previous years, and is exceptionally well qualified for the work.

This class offers a good chance for instruction to young men who are anxious to learn and to advance themselves in their business. The total cost of the winter course is between $10 and $11 only, and this includes a year's membership in the Institute, with all its advantages. Further information can be had by application to the Secretary at No. 222 Bowery.

Baltimore Notes.

THE work of excavating for the Belt Railroad Tunnel has progressed so far from the shafts that it is now necessary to use some kind of power in moving the cars which run on the narrow-gauge construction railroads that are laid in the tunnel, and upon which the earth is hauled out, and the lime, brick, sand, and cement carried up to the headings and side drifts. Steam locomotives will not do, as they give out smoke, and the time is approaching when apparatus will be required for giving fresh air to the miners and workmen. The plant for an air compressor is now being put up at the lot corner of Park Avenue and Preston Street to supply fresh air to all of the shafts. An electric motor has been found impracticable for hauling the cars in the tunnel, as one would be required for every train; so the contractors are now experimenting with a plant that will use the trolley system. In some places the roof is so low that a long, rigid, upright trolley pole will not allow the work trains to run up into the low headings, and a trolley has been devised to work with a double rod, each one having a hinge or knuckle in the center, and it can double up and lie almost flat on top of the car in either direction, when its full-length extension would be obstructed by the earth or over head timbering.

THE Wenstrom Dynamo & Motor Company, located at Calverton, suspended operations temporarily on August 18, throwing about 70 men out of employment, and causing much dissatisfaction, as the men were not paid off. The trouble is said to be due to some difficulty arising between the stockholders and bondholders of the Company, which, it is said, will be amicably adjusted.

IT is reported that the Baltimore & Ohio Southwestern Railroad Company has purchased a large tract of land in Belpre, O., opposite Parkersburg, W. Va., adjoining the cattle-yards and hotel property of the Company, and that a number of switches will be laid, upon which the heavy engines will be run, instead of crossing the river to the West Virginia side, as has been done in the past.

THE Baltimore & Ohio and the Baltimore & Ohio Southwestern are having some very handsome cars built at Pullman, which are intended for a through line to Cincinnati, connecting at Baltimore with the "Royal Blue Line" for New York, making a splendid service through from New York to Cincinnati. The cars, coaches and baggage cars will all be painted the Pullman standard color, and will all be lettered "New York, Washington, Cincinnati & St. Louis;" the cars belonging to the Baltimore & Ohio to have the coat-of-arms of Maryland on the side, and those belonging to the Baltimore & Ohio Southwestern the coat-of-arms of Ohio. The train will probably be called the "B. & O. Southwestern Limited," this marking being placed on the side of the baggage car. These cars will be vestibuled, and will be carpeted and have window curtains, the designs of the interior finish being all fresh and new, and the lighting will be by Pintsch gas.

Paint.

A LARGE number of tests, made by painters who have no personal interest in the matter, have, it is claimed, proved that Dixon's graphite paint will cover a much larger surface than any other lead or mineral paint. Some 20 years' experience has also proved that on metal work—a tin roof, for instance—it will last from 10 to 15 years before repainting is needed. This is a remarkable durability.

PERSONALS.

W. B. W. HOWE, JR., has resigned his position as Chief Engineer of the Savannah, Florida & Western Railroad.

STEPHEN LITTLE, formerly connected with the Erie, the Northern Central, and some other roads, is now Controller of the Denver & Rio Grande Company.

D. B. ROBINSON, for some years past General Manager of the Atlantic & Pacific Railroad, is now General Manager of the San Antonio & Aransas Pass Railroad in Texas.

SAMUEL GARWOOD has been chosen Vice-President of the American Steel Wheel Company of Boston. He was recently connected with the Philadelphia & Reading Railroad.

F. H. ROBINSON, recently Assistant Engineer of the Philadelphia, Wilmington & Baltimore Railroad, has been chosen Professor of Civil Engineering in Delaware College at Newark, Del.

J. A. DROEGE has been appointed Superintendent of the Middle Georgia & Atlantic Railroad, with office at Eatonton, Ga. He was recently connected with the East Tennessee, Virginia & Georgia Railroad.

N. O. WHITNEY, for some years past Assistant to the Chief Engineer of the Pennsylvania Company, has resigned that position to become Professor of Railroad Engineering in the University of Wisconsin.

ROBERT H. CAMPBELL has been appointed General Superintendent of the Trans-Ohio Divisions of the Baltimore & Ohio Railroad, with headquarters in Chicago, succeeding EDWARD DICKINSON, who has resigned.

T. J. NICHOLL, recently on the Louisville, New Orleans & Texas, has opened an office as Consulting Engineer at No. 206 Cass Street, Chicago. Mr. Nicholl has had an extensive experience in bridge and railroad work.

SANFORD KEELER has resigned his position as Superintendent of the Flint & Père Marquette Railroad, after 31 years' service on the road in various positions. W. A. POTTER, late Assistant Superintendent, succeeds Mr. Keeler.

C. F. MUSSELMAN, for four years past General Foreman of the shops, has been appointed Master Mechanic and Master Car Builder of the Cincinnati, Portsmouth & Virginia Railroad, with office in Portsmouth, O. He succeeds J. C. HOMER, who resigned to accept service elsewhere.

OCTAVE CHANUTE, President of the American Society of Civil Engineers, is now devoting special attention to the preservation of ties and timber, of which he has made a careful study for some years past. Mr. Chanute is prepared to design or erect works for the treatment of timber, and to conduct tests or experiments in this direction.

OBITUARY.

James R. Ogden, who died in Knoxville, Tenn., August 1, aged 54 years, was for many years connected with the East Tennessee, Virginia & Georgia Railroad, and was General Freight Agent of that road for 20 years. He left that road in 1886, and was for a year Vice-Commissioner of the Southern Railroad & Steamship Association. In 1887 he became President of the Knoxville Car-Wheel Works and the Knoxville Iron Company, and continued in that position until his death.

Walter L. Bragg, who died at Avon-by-the-Sea, N. J., August 21, aged 53 years, was born in Alabama, and lived in that State or in Arkansas all his life. He served in the Confederate Army during the war. In 1881 he was appointed President of the Alabama Railroad Commission, and held that office till 1887, when he was appointed one of the first members of the Interstate Commerce Commission. He held that position until his death. He was a hard worker, and was a most active and useful member of the Commission.

William W. Wilson, who died in Chicago, August 10, aged 59 years, was born in Rochester, N. Y., and served an apprenticeship in the old Erie shops at Dunkirk. After working on various roads he was made General Foreman of the Galena & Chicago Union shops in Chicago in 1859. In 1865 he was appointed Division Master Mechanic on the Chicago, Burlington & Quincy, and in 1875 was made General Master Mechanic of the road. In 1879 he left to become Master Mechanic of the Wabash, and in 1880 was appointed Superintendent of Machinery of the Chicago & Alton Railroad. That position he held until a year ago, when he resigned on account of ill health; he has since been unable to undertake any active work.

John Luther Ringwalt, who died in Philadelphia, July 29, had been for 16 years editor of the *Railway World* of that city. He was born in Lancaster, Pa., in 1828, and began work in a newspaper office at an early age. He was connected with several papers, including the Philadelphia *Press*, and in 1875 became editor of the *Railway World*, having previously been an occasional contributor to its predecessor, the *Railroad & Mining Register*. For some time he continued his labors on the *Press*, but during the last 15 years the bulk of his literary labor has appeared in its columns. He had, however, done much incidental writing for other journals, among which may be named the Philadelphia *Inquirer*. Mr. Ringwalt also published two books requiring much labor, the American Encyclopædia of Printing and the Development of Transportation Systems in the United States. He was a hard—almost an incessant—worker, but found time to make many friends, who will most sincerely regret his loss.

John S. Gilbert, who died at Fort Montgomery, N. Y., August 13, aged 90 years, was born in East Haddam, Conn. In his youth he learned the trade of a ship's joiner. While engaged in this work in New York he began to study into the question of improving the methods of getting big ships out on a dock so that repairs might be made more handily. After his work for the day was over he would pass evenings in studying out improvements, and as a result invented finally the balance dry dock. His success in life was from that moment assured, and soon he was engaged in building the dry docks all over the world, and became as well a naval architect. He lived for many years in New York, and there organized the original New York Dry Dock Company, and over 40 years ago built the Erie Basin dry dock. Afterward came an appointment as Naval Constructor at Washington, an office that he held for several years. He built large dry docks at Kittery, Me., and at Charleston, and superintended the construction of that at Mare Island. Abroad he earned the title of Naval Constructor from the Austrian Government, and received various honors from Archduke Maximilian. He retired from business about 30 years ago, with a moderate fortune.

PROCEEDINGS OF SOCIETIES.

Engineers' Society of Western Pennsylvania.—At the regular meeting in Pittsburgh, June 16, Mr. C. Davis reported that the Library Fund was very low, and suggested that those who felt so disposed could or should donate toward this fund to pay for the binding of the unbound volumes now on hand, the donations to be sent to Mr. C. Davis, or to the treasurer.

There being no further business, the paper of the evening was read by Mr. Harry J. Lewis, on Bridge Design. This was generally discussed by members present.

Technical Society of the Pacific Coast.—At the regular meeting in San Francisco, July 3, eight new members were admitted.

Two papers were presented: one on Abrasive Processes in the Mechanic Arts, by Mr. J. Richards, and one by Mr. Marsden Mansen, C.E., former President of the Society, on the Physical and Geological Traces of Permanent Cyclone Belts.

These papers had a peculiar interest. The first because it treated on a subject that has scant recognition in technical literature, and the second, because it enters upon a bold hypothesis, supported, however, by much observable data. Both of these papers will be published in an early bulletin of the Society.

At the regular meeting in San Francisco, August 7, A. J. Brownlie, F. T. Newberry and Emil Neuman were elected members.

Mr. Hubert Vischer read a paper on the use of the figure 9 in arithmetical calculations as an aid to engineers in their computations, and President John Richards delivered an address on Natural Standards, referring particularly to meter, pendulum and contact gauges in mechanical work.

Master Car & Locomotive Painters' Association.—The 22d annual convention will be held in Washington, beginning September 9. The Arlington Hotel will be headquarters.

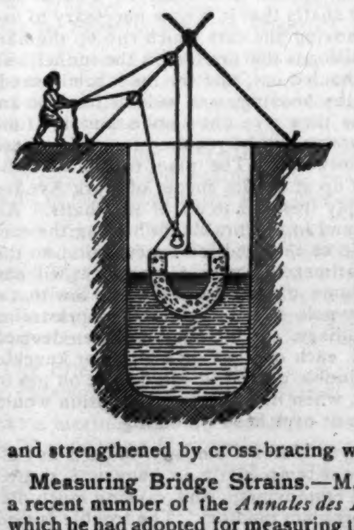
A cordial invitation is extended to all foremen car and locomotive painters throughout the States and Canada, to meet in convention; this being the first meeting at the National Capital, affords an opportunity to visit many places of interest after the close of the session.

American Association for the Advancement of Science.—The 40th annual meeting began in Washington, August 19. The meeting was called to order by the retiring President, Professor George L. Goodale, of Harvard University, who introduced the President-elect, Professor Albert B. Prescott, of Michigan University. Addresses of welcome were made by Hon. Edwin Willits, Assistant Secretary of Agriculture, and Dr. J. C. Welling, President of the Columbian University. These addresses were responded to by Dr. Prescott.

An amendment to the constitution was proposed at the last meeting, providing for the election of foreigners as corresponding members of the Association. The amendment was carried by an almost unanimous vote.

NOTES AND NEWS.

A Well Water Filter.—The accompanying sketch, from *Indian Engineering*, shows a cheap and simple filter for wells which was designed by Mr. Henry W. Allen and has been extensively used in the Madras Presidency. The device seems to be a very good one for wells and cisterns of doubtful water which must be used until a better supply can be found.



Two baskets are used, with the space between the baskets filled with charcoal, coarse sand and gravel. They are suspended in the well, as per sketch, and the well water, in percolating to the inner basket to replace water as drawn, gets well filtered. The outer basket is made 6 ft. in diameter, and strengthened by cross-bracing with the inner basket.

Measuring Bridge Strains.—M. Le Chatelier describes in a recent number of the *Annales des Ponts et Chaussées* a method which he had adopted for measuring the strains in the members of an iron or steel bridge. For this purpose a bracket carrying a lathe center is attached by small screws to the member the strain in which is to be measured. At another point of this bar a second bracket is fixed, in which slides a short steel rod

pointed at both ends like a lathe center. Attached to the same bracket is a water chamber closed by a flexible diaphragm of German silver and connected to a fine open tube, in which the water, on being expelled from the chamber, flows and serves to measure on a highly magnified scale any motion of the diaphragm. One end of the double-centered rod presses against this diaphragm, and a bar is supported on the other center point of this rod and on that of the fixed bracket before mentioned. Any extension of the bridge member, therefore, causes a motion of the diaphragm and a fall of the water in the fine tube. Successful measurements are said to have been made on this system when the fixed points between which the extension was taken were only 8 in. apart.

An Old Method of Building Arches.—The accompanying cuts, from *le Genie Civil* show a method of building arched conduits used by the Persians in ancient times. The conduits uncovered at Khorsabad have semi-circular (fig. 1) and ogival (fig. 2) sections; a few are also elliptical, but all are built in the manner shown.

The ogival arches are not closed by a key-stone, the opening at the top of the brick courses being filled by clay well rammed down. In building, the mason evidently began his work of arching by forming inclined bases on the side walls, on which the first course of the arch was started. The succeeding courses followed the inclination of the first.

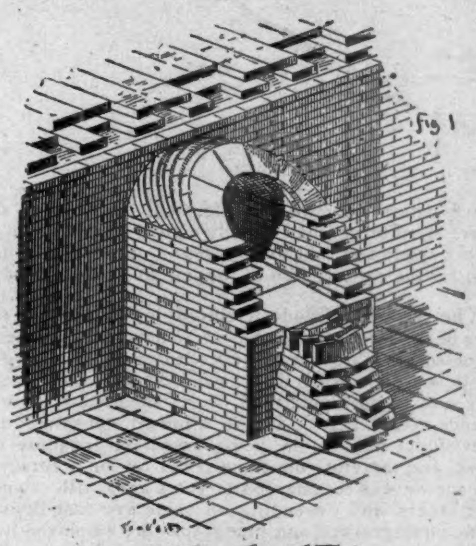
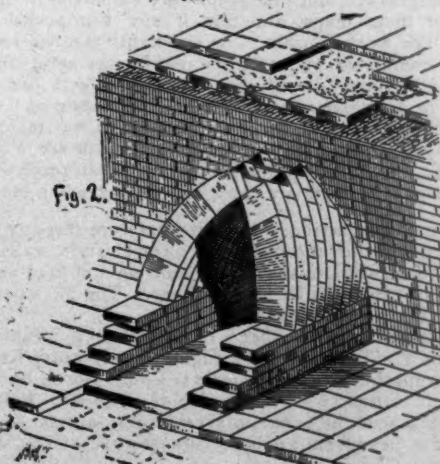


Fig 1

Fig. 2.


The method was certainly ingenious. It has the advantages of dispensing with the use of arches, and of quickness in execution. Modern masons may take some hints from their old Persian predecessors.

An Electric Launch.—The cut given herewith, from the *Steamship*, shows a pinnace built by Woodhouse & Rawson, of London, in which the screw is worked by an electric motor. The power is furnished by storage batteries carried on the boat. She is named *Electric*, was specially constructed for the conveyance of troops, and is used for that purpose between the

dockyards at Chatham and Sheerness. The craft is 48 ft. 6 in. in length over all by 8 ft. 9 in. beam, with an average draft of 2 ft. 3 in., her full complement being 40 fully equipped soldiers. Her speed averages eight knots per hour, and for cases of emergency she is fitted with two masts, two balance lug sails, and a stay sail, thus enabling her to be sailed or propelled electrically, and to do the same as a steam pinnace of her size. Messrs. Woodhouse & Rawson have a special accumulator which has been under test for several months, and which has given remarkable results; and the employment of this accumulator for launches is expected to lead to considerable extension in the immediate future. It is claimed that the use of electric pinnaces presents considerable advantages over the existing type of steam pinnace, because not only is the electric pinnace always ready for use at a moment's notice, but the carrying capacity for size and accommodation is considerably greater than that of a steam pinnace. The actual cost of propulsion per mile does not exceed that of steam vessels with similar carrying capacity; and one great advantage is that no skilled hands are required for stoking and engineering purposes.

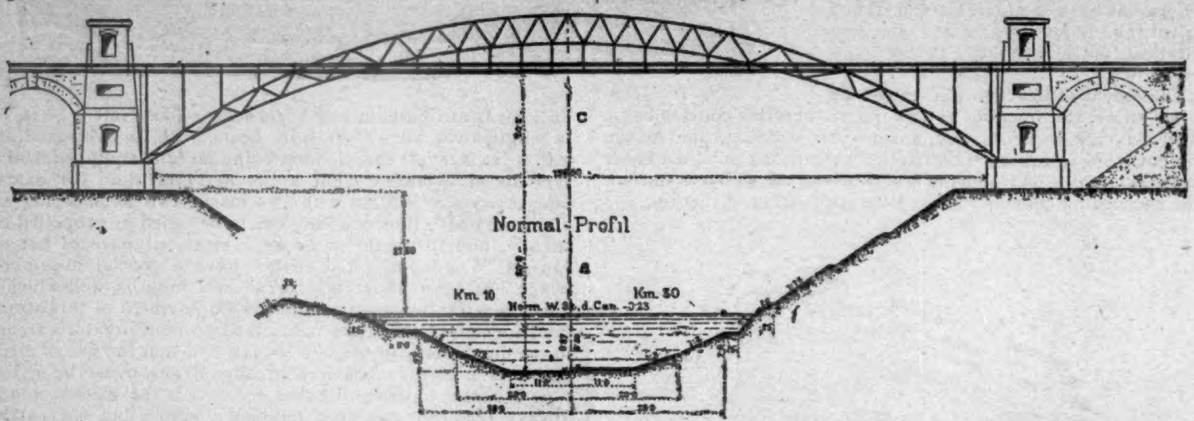
The Congo Railroad—A section of the Congo Railroad from Matadi to the Leopold Ravine, two miles, has been opened, and the first Belgian locomotives are running within sound of the Falls of Yellala, the insurmountable impediment that is met by steamers ascending the lower Congo. Of course there is no passenger traffic yet, but the locomotives and 10-ton trucks are greatly expediting the work of road building, by facilitating the transport of earth, stone, and other material. It is expected next month that 4,000 men will be at work on different points of the line which is to connect Matadi, at the head of navigation on the lower Congo, with Leopoldville on Stanley Pool, 235 miles away. The work, thus far, has progressed satisfactorily, and the engineers anticipate no serious impediments.—*Goldthwaite's Geographical Magazine.*

A California Mining Plant.—The Dalmatia Mine and mills are situated far up in the California mountains distant from Placerville, the nearest railroad station, about 15 miles, and nearly 60 miles northeast of Sacramento. The mining camp of Kelsey, where the Dalmatia Mine is located, is 1,500 ft. above the sea. Fuel is dear, and the question of obtaining power for operating the mills is a serious one. The mine is owned by an English syndicate, and is under the management of Mr. G. C. Pearson. After considerable deliberation it was decided to install an electrical power plant. The nearest water is Rock Creek, a stream running down from the mountains into the western fork of the American River. The creek was tapped about two miles above the point where it empties into the river, and the water was then led through ditches dug and blasted along through the rocky soil until a point was reached about 100 ft. above the river and 200 ft. away from it; at the junction close down by the river bank was placed the power station, and the water is led into it through an iron pipe 28 in. in diameter running down the hill-side. At the power house is installed a large Pelton water-wheel that drives a jack-shaft to which is belted a Brush compound wound generator giving 1,800 volts and 40 ampères. The current from this is led through a circuit of No. 3 copper wire over the mountains to the mills one and a half miles distant from the power house. The complete cir-

cuit is therefore a little more than three miles in length. Here the motor equipment is situated and drives the stamps, settlers, and other mining machinery. The plant was installed by Mr. H. S. Connor, the electrician of the Brush Electric Company, and from the very start has given excellent satisfaction. Mr. Pearson, the Manager of the mine, is so thoroughly pleased with the installation, that he is now considering the possibilities of the American River as a source of future power. It is a considerable stream, and an enormous amount of energy is running to waste that might well be utilized in mining operations throughout the surrounding country. Altogether the Dalmatia plant is a capital specimen of the economical and effective way in which electric power can be utilized.—*Electrical World.*

The Grunthal Bridge.—The accompanying illustration shows the high bridge over the Baltic-North Sea Ship Canal at Grunthal, which is a notable structure. It has a span of 156.5 meters (513.3 ft.); a clear height of 42 m. (137.8 ft.) above water-level of the canal, and of 51.3 m. (168.3 ft.) above the canal bed.

The bridge shown in this sketch spans the canal near the center of the Grunthal cut, the heaviest work on its whole length.



The lower part of the cut shows the cross-section adopted for the canal; on one side the section in the cutting at the bridge is given, and on the other the section in open country.

At the point where the bridge crosses the bank is 21.5 m. (70.5 ft.) above the water-level, and the depth of the canal is 9.3 m. (30.5 ft.). The cutting is in earth, the soil being light and sandy.

California Petroleum.—The present petroleum product on the Pacific Coast is set down as 1,300 barrels daily, of which 40 per cent. is made into a fuel product, used for gas and for fuel. There is but little paraffine in California coal oil; the residue, corresponding to paraffine in Eastern oils, is pitch, or asphaltum, as it is usually called, and is used for varnishing, painting, coating pipes, and in street pavement construction.—*Industry, San Francisco.*

Aluminium Iron by the Stefanite Process.—In this process aluminium is introduced into the iron while the latter is in a molten condition, either in the cupola or in the puddling furnace. The separation of the aluminium from its mineral takes place during the operation with the melting of the iron, the new formed metal combining itself at once with the iron. It is known that aluminium in a very small proportion lowers the melting point of iron and steel, and that it makes these metals very fluid in such a way that they can be cast easily and without blow-holes. The adoption of this process has been heretofore prevented by the high price of aluminium, but the great reduction recently made will do away with this objection. The Stefanite process was specially intended to reduce the price of production, and the trials made with it heretofore have been in Germany.

The operation consists in the addition to the iron in the furnace or cupola of emery and alum, either in powder or formed into briquettes. It seems that the reaction of the alum on the emery produces metallic aluminium in the form of a vapor, which at once unites with the iron and gives the latter the special qualities which have heretofore only been obtained by the addition of aluminium to iron or steel in the crucible. The process of casting does not again volatilize the aluminium, which remains combined with the iron. When the addition is made to iron in the puddling furnace the wrought iron produced can be hardened and tempered like steel, and its tensile strength, is considerably increased.—*Revue Scientifique.*

The Australian Intercolonial Railroad.—The links of the Intercolonial Railroad chain are not yet complete; and while South Australia is preparing the way for a line to directly tap the rich pastoral districts of Southwestern Queensland, and thus draw their trade to her own northern ports, the people of the Barrier silver fields are earnestly agitating for a railroad to connect Broken Hill with the New South Wales system at Cobar, and thus complete direct rail communication between Adelaide and Sydney. But an infinitely vaster and more important project than any of these is that for the connection of Perth with Port Augusta. The project has for some years past been before the public of both South and West Australia, but in the former colony was shelved as impracticably expensive and probably unremunerative, while in the latter want of means and a certain lack of enterprise, coupled with the uselessness of moving in the matter without South Australia's co-operation, have combined to prevent the taking of active steps for the realization of the scheme. Now, however, we hear that both South and West Australia have been stirred into progressive action; that the former colony is preparing to make a survey of the proposed line to her own border at Eucla, the lone telegraph station on the Great Australian Bight, which is jointly maintained by the two colonies. In West Australia more decisive action has, we are informed, been taken, and its premier, Mr. Forrest, has actually signed a provisional agreement with a syndicate, said to represent a number of British capitalists, for the construction of the line to Eucla.—*Iron.*

The Japanese Geodetic Survey.—According to the *Proceedings* of the Royal Geographical Society, the Japanese Government surveys are making excellent progress. A general map of Japan on a scale of 1 : 200,000 was commenced 16 years ago, and is now published (in 77 sheets) for the whole of the islands except Yezo. This is, however, considered merely as a provisional publication, being based on Japanese methods of work, and therefore not to be relied on for accuracy. A modern survey was commenced 11 years ago, with triangulation of four orders, and depending on some five base-lines. Copperplate, photogravure, and lithography are employed in the reproduction of these maps, and few if any Europeans are employed. The work appears to be excellent. Only a small proportion is completed, and it will be many years before the whole is finished. About 300 of the published sheets can now be bought: the scale is 1 : 20,000. A map on a scale of 1 : 100,000 is also being prepared, based on the 1 : 20,000 map, but no sheets are yet for sale. The names on these maps are in Japanese characters. In the Geological Survey of Japan reconnoissance map, Roman characters are used, and 1 : 400,000 is the scale.

Snow in Fortification.—Experiments were recently made in Russia to determine the resisting power of snow walls against artillery. Two walls of snow were built up and fired against at a distance of 600 yards by field artillery. The balls penetrated a distance of 18 ft. into the walls.

The Russians have also been recently trying infantry firing at snow walls. The men of the Eighty-first Infantry Regiment, under the superintendence of General Count Boref, built a wall about 50 ft. long, 18 ft. thick, and 4½ ft. high. Behind the walls were placed, at equal intervals, four targets, at each of which four volleys were fired, at distances of 800, 400, 200, and 100 paces.

The penetrating powers of the volleys were: At 100 paces, 9 ft; at 200 paces, 5 ft. 7 in.; at 400 paces, 4 ft. 7 in.; at 800 paces, 4 ft. Experiments made in our own Army, however, seem to show that the resisting power of snow is less than indicated by these experiments. When compressed, however, its resistance is very much increased.